

**DRAFT**

**TECHNICAL IMPRACTICABILITY  
DEMONSTRATION REPORT**

**SOUTH CAVALCADE SUPERFUND SITE  
HOUSTON, TEXAS**

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- A** COMPILATION OF ARARS

## LIST OF ABBREVIATIONS/ACRONYMS

AOC	January 24, 1992 Administrative Order on Consent between USEPA and Property Owners
ARARs	Applicable, or Relevant and Appropriate Requirements
Beazer	Beazer East, Inc.
BTEX	Benzene, Toluene, Ethylbenzene and Xylenes
COIs	Constituents of Interest
CSM	Conceptual Site Model
DNAPL	Dense Non-Aqueous Phase Liquid
FFS	Focused Feasibility Study
GFTER	Groundwater Fate & Transport Evaluation Report
gpd	gallons per day
GWI	Groundwater Insight, Inc.
HCTRA	Harris County Toll Road Authority
HGCSD	Houston-Galveston Coastal Subsidence District
IS/S	In-Situ Solidification/ Stabilization
KEY	Key Environmental, Inc.
Koppers	Koppers Company, Inc.
MNA	Monitored Natural Attenuation
MSD	Municipal Settings Designations
NCP	National Contingency Plan
NPL	National Priorities List
PAHs	Polycyclic Aromatic Hydrocarbons
RAOs	Remedial Action Objectives
RAWP	Remedial Action Work Plan
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SGCR	Supplemental Groundwater Characterization Report
SITE	South Cavalcade Superfund Site
TCEQ	Texas Commission on Environmental Quality
TI	Technical Impracticability
TRRP	Texas Risk Reduction Program
USEPA	United States Environmental Protection
VGFTER	Verification of Groundwater Fate & Transport Evaluation Report

## 1.0 INTRODUCTION

Key Environmental, Inc. (KEY) and Groundwater Insight, Inc. (GWI) have prepared this Technical Impracticability (TI) Demonstration Report on behalf of Beazer East, Inc. (Beazer) for groundwater at the South Cavalcade Superfund Site (Site) located in Houston, Texas. The location of the Site is shown on Figure 1-1. The TI Demonstration Report will form the technical basis to support a change to the groundwater remedy for the Site as recommended in the Focused Feasibility Study (FFS) Report (KEY/GWI, 2011).

### 1.1 PURPOSE OF THE REPORT

The purpose of the report is to:

- Document the removal, to the extent practicable, of the principal source of groundwater impact (Dense Non-Aqueous Phase Liquid (DNAPL) comprised of creosote or coal tar);
- Document the technical impracticability of additional removal of source material;
- Demonstrate the technical impracticability of restoring groundwater to meet the remedial goals specified in the Record of Decision (ROD) and other applicable, or relevant and appropriate requirements (ARARs); and,
- Assist in the development of a Proposed Plan and ROD Amendment to support the change from the groundwater remedy selected in the ROD to the groundwater remedy recommended in the FFS Report.

The report contains all of the applicable and appropriate information as stipulated in the U.S Environmental Protection Agency (EPA) Guidance Document titled *Guidance for Evaluating the Technical Impracticability of Ground-Water Restoration* (EPA 1993).

### 1.2 EVALUATION CRITERIA

The applicability and appropriateness of a TI Waiver is evaluated according to the following three criteria as stated in the EPA 1993 Guidance Document referenced above:

- Hydrogeologic factors (e.g., permeability, heterogeneity);
- Contaminant-specific factors (including presence of DNAPL); and,
- Technological limitations (including design and implementation considerations).

In addition, the following site-specific criteria are evaluated for the groundwater at the South Cavalcade Site:

- Land use considerations (effects on property owners use of the property); and,
- Exposure considerations (no groundwater use or potential discharge of groundwater to surface water).

A detailed evaluation of these criteria is presented in Section 3.0 of this report.

### 1.3 TI REQUIREMENTS ADDRESSED IN THE FFS

The EPA's TI Guidance indicates that a TI evaluation should include the following components:

- Specific ARARs for which TI Waiver are sought;
- Spatial areas over which the TI decisions will apply;
- Site Conceptual Model;
- An evaluation of the restoration potential of the site; and,
- Estimate of the costs of the existing or proposed remedial options.

Much of the information needed for the TI Demonstration has been previously developed and submitted in prior reports to the EPA and Texas Commission on Environmental Quality (TCEQ). Where appropriate, references are made to the applicable sections of the previous reports rather than duplicating the bulk of the information. Brief summaries are incorporated herein for completeness. The following table is provided as a cross-reference for information presented in the FFS which also addresses the content requirements for a TI demonstration.

<b><i>TI Requirements</i></b>	<b><i>Section in FFS</i></b>	<b><i>Section in TI Demonstration Report</i></b>
ARARs to be Waived	5.3	3.2
Spatial Areas Over Which the TI Decisions Will Apply	NA	3.3
Site Conceptual Model	4.0	2.5.1 - 2.5.5
Site Description and History	3.0	2.1 - 2.4
Geology	4.1 - 4.2	2.5.1
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## 2.0 SITE DESCRIPTION

### 2.1 SITE CHARACTERISTICS

This Site characteristics description is largely excerpted from the Verification of Groundwater Fate and Transport Evaluation Report (VGFTER; KEY, 2000). The Site includes approximately 66 acres of urban land located approximately three miles north of downtown Houston, Texas. As shown on Figure 2-1, the Site is rectangular in shape and is approximately 3,400 feet long in the north-south direction by 900 feet long in the east-west direction.

A wood treating plant operated at the Site from 1910 until 1962. Creosote and various metallic salts were used as the wood preservatives. The wood treating process area was located in the southern portion of the Site along Collingsworth Street. Koppers Company, Inc. (Koppers), now known as Beazer, operated the wood treating facility from 1940 until its closure in 1962. A coal tar distillation plant was also operated by Koppers on the southeastern portion of the Site from about 1944 until 1962.

The Site is currently occupied by three trucking firms; thus, much of the ground surface, especially in the southern and northern portions of the Site, is covered by concrete or asphalt pavement, or buildings, as shown on Figure 2-1. The on-Site groundwater treatment facility is located along the eastern property boundary in the central portion of the Site. The remainder of the central portion of the Site has historically been undeveloped and therefore soil and groundwater in this area has not been affected. No surface water bodies exist on-site.

### 2.2 LAND USE

Land use in the vicinity of the Site is a mixture of commercial, industrial and residential. Industrial and commercial properties are located to the east and across Collingsworth Street to the south of the Site. The North Cavalcade Superfund Site, which is also the location of a former wood treating facility, is located directly across Cavalcade Street to the north. Active rail lines immediately border the Site to the east and west. The nearest residences are located several hundred feet west of the Site.

The Harris County Toll Road Authority (HCTRA) is planning an extension of the Hardy Toll Road which will border the western Site boundary. As a result, the HCTRA is in the process of acquiring the railroad right-of-way and certain properties to the west of the Site. According to the HCTRA, construction of the road is scheduled to begin in the near future. The Hardy Toll Road construction will further separate the Site from the residential area to the west and eliminate the already highly unlikely potential for future use of groundwater in the areas to be occupied by the highway. The potential for future groundwater use in the vicinity of the Site is further discussed in Section 2.3.5 of the report.

Continued future use of the Site properties for non-residential purposes is ensured, because deed restrictions for on-Site properties are in place and the January 24, 1992 Administrative Order on Consent (AOC) between USEPA and the respective property owners prohibit property use for residential purposes. The AOC between USEPA and the respective property owners also prohibit on-Site groundwater use. Future institutional controls will need to be established to prohibit off-site groundwater use in the affected areas.

## **2.3 REGULATORY HISTORY**

A detailed discussion of the Site regulatory history is presented in Section 3.3 of the FFS. A summary of this history is as follows:

The Site was added to the National Priorities List (NPL) in June 1986. After completion of the Remedial Investigation/Feasibility Study (RI/FS), the ROD was issued in 1988. The final (100%) remedial designs for the Site were approved by USEPA in December 1994. Following approval of the remedial designs, Beazer prepared the Remedial Action Work Plan (RAWP) which presented the procedures and requirements for construction of the remedial alternatives. The RAWP was approved by USEPA in May 1995.

Remedial construction was initiated in June 1995. In July 1997, the ROD was amended to change the remedy for soil at the Site to a concrete cap. Construction of the soil remedy was completed in July 2000.

Passive operation of the DNAPL recovery system was initiated in January 1996. Beazer operated the DNAPL Recovery System in the gradient enhanced mode from October 1996 until April 2006 when groundwater recovery was discontinued after the groundwater treatment system controller became inoperative as a result of a lightning strike. Since that time, DNAPL recovery has been conducted in a passive mode without groundwater recovery. Operation of the remedy for dissolved phase constituents in groundwater has been delayed pending a determination of the applicability of the groundwater remedial goals for the Site.

## **2.4 REMEDIAL ACTION HISTORY SUMMARY**

Remedial Action has been conducted at the Site to address three separate media. Specifically, soil, groundwater, and DNAPL Remedial Actions have been conducted. The Remedial Action history for each of these media is discussed in detail in Section 3.4 of the FFS. A summary of this information is provided in the following paragraphs.

### **Soil**

The remedy constructed for soil at the Site is a concrete cap. The soil concrete cap system covers the impacted as well as non-impacted areas in the Southeast and the Southwest Areas of the Site therein providing usable parking and driveway systems for the current property owners. The extent of the concrete cap is shown in Figure 2-1. The concrete cap is 8 inches thick in the

Southwest Area and 10 inches thick in the Southeast Area. Capping did not take place in the Northeast Area. Soils in the Northeast Area were excavated and were used as fill under the concrete cap structures in the Southeast and Southwest Areas. The Northeast Area was backfilled with clean imported fill from an off-site source.

### **Groundwater**

The groundwater remedial alternative selected in the ROD included extraction and treatment of groundwater containing constituent concentrations greater than the remedial goals specified in the ROD. The ROD stipulated that “groundwater collection will continue until constituents have been recovered to the maximum extent possible”, as “determined during the Remedial Action, based upon experience in operating the groundwater collection and treatment system.” The ROD also specified that once USEPA had determined that groundwater constituents have been recovered to the maximum extent possible, groundwater collection would cease and any remaining constituents would be allowed to naturally attenuate to background levels. The ROD also indicated that the groundwater could be remediated via in- situ biological treatment if equal performance was demonstrated.

In June 1995, construction of the groundwater remedial action was initiated in accordance with the RAWP. One DNAPL recovery well (RWN-4) and four groundwater collection wells (RWN-1, RWN-2, RWN-3 and RWN-5) were installed within the Northern Area of the Site. One DNAPL recovery well (RWS-5) and three groundwater collection wells (RWS-3, RWS-4, and RWS-6) were installed within the area formerly occupied by the coal tar distillation plant in the southeastern portion of the Site. Two combined groundwater collection/DNAPL recovery wells (RWS-1 and RWS-2) were installed within the area formerly occupied by the wood treating process area in the southwestern section of the Site. Figure 2-1 shows the locations of the Groundwater and DNAPL recovery wells.

In addition to the operation of the DNAPL recovery system, Beazer has conducted annual groundwater monitoring in two deeper monitoring wells located in the vicinity of the Site, as stipulated in the Remedial Design Work Plan. One well monitors the “200-Foot Sand” aquifer at a depth of approximately 220 feet below ground surface and the other well monitors a deeper sand unit at approximately 500-feet below ground surface. The results of this monitoring show that these groundwater-bearing units have not been impacted by Site-related constituents.

In September 1995, start-up of the groundwater collection and DNAPL recovery components of the groundwater remedy was conducted, following completion of modifications to the groundwater treatment plant. Shortly thereafter (October 6, 1995), EPA prepared a letter to Beazer stating that “there is some question as to whether USEPA will continue to apply the current remedial action goals [i.e., the remedial goals specified in the ROD issued in 1988] to groundwater cleanup.” This direction was taken in response to an internal July 31, 1995 EPA memorandum directing a policy favoring ARAR waivers at sites where it is technically

impracticable to remediate groundwater to Federal or State standards. Consequently, and in accordance with an agreement between EPA and Beazer, groundwater collection and treatment was delayed pending determination of the potential inapplicability of the groundwater remedial goals specified in the ROD. Operation of the DNAPL recovery component of the groundwater remedy continued. This TI Demonstration Report is the culmination of the evaluation of the applicability of groundwater remedial goals which was initiated in response to the EPA' October 6, 1995 correspondence.

Numerous investigations and fate and transport evaluations were subsequently performed to further characterize the site in terms of an MNA remedy for groundwater at the Site. These results of these efforts are summarized in the following documents;

- Groundwater Fate and Transport Evaluation Report (KEY 1997)
- Verification of Groundwater Fate and Transport Evaluation Report (KEY 2000)
- Supplemental Groundwater Characterization Report (KEY 2005)

A meeting was held in Austin, Texas among representatives of Beazer, EPA and TCEQ in April 2006 to discuss the next steps in the evaluation of the existing groundwater remedial goals. All parties agreed that an FFS should be prepared to evaluate potential alternate groundwater remedies. The draft FFS was submitted to EPA and TCEQ in May 2007. Following receipt of comments from EPA and TCEQ, the FFS was revised and resubmitted to the agencies in October 2007. Activities conducted to evaluate the applicability of the ROD remedial goals and alternate groundwater remedies are summarized in the following table:

YEAR	ACTIVITY	OBJECTIVE
1997	Groundwater Fate and Transport Evaluation Report (GFTER)	Preliminary evaluation of whether natural attenuation processes are sufficient to meet the remedial objectives for shallow groundwater at the South Cavalcade Site.
2000	Verification of the Groundwater Fate and Transport Evaluation Report (VGFTER)	Site investigation to further evaluate the MNA conclusions of the GFTER.
2006	Supplemental Groundwater Investigation Report	Define groundwater migration pathways for the shallow and intermediate aquifers, as they pertain to contaminant distributions and to refine the delineation of the dissolved phase plume in the area southwest of the Site.
2007	Focused Feasibility Study	Evaluate potential alternate groundwater remedies.

## **DNAPL**

Beazer began start-up operations for the four DNAPL recovery wells at the Site (RWS-1, RWS-2, RWN-4, and RWS-5) in the fall of 1995. Passive operation of the DNAPL recovery system (i.e. collection of DNAPL without groundwater pumping to increase hydraulic gradients) was

initiated in January 1996 in accordance with the EPA-approved 100% Remedial Design. Evaluation of the DNAPL recovery data collected through June 1996 indicated that DNAPL had been recovered to the “maximum extent possible” under the passive mode of operation. DNAPL recovery, with groundwater extraction to enhance hydraulic gradients, was initiated in two recovery wells (RWS-1 and RWS-2) to evaluate the effectiveness of this approach. Evaluation of the data through September 1996 indicated that groundwater extraction enhanced DNAPL recovery in Wells RWS-1 and RWS-2. As a result, DNAPL recovery with groundwater extraction was initiated in RWN-4 and RWS-5 in October 1996. Beazer continued operation of the DNAPL Recovery System in the gradient enhanced mode until April 2006 when groundwater recovery was discontinued after the groundwater treatment system controller became inoperative as a result of a power surge (probably caused by a lightning strike). Since that time, DNAPL recovery has been conducted in a passive mode without groundwater recovery in accordance with approval from EPA and TCEQ. Data collected during the operation of the DNAPL recovery system have shown a decrease in the rate of recovery over time to where only de minimis quantities can be removed within a reasonable timeframe. Thus, DNAPL has been removed to the maximum extent practicable. The following table presents a timeline of the DNAPL Recovery System Operations

Time Period	DNAPL Recovery System Operation
September 1995 – October 1995	System Start-Up Gradient Enhanced Operation in RWS-1, RWS-2, RWS-5 and RWN-4
January 1996 – June 1996	Passive Recovery Operation in RWS-1, RWS-2, RWS-5 and RWN-4
June 1996 – September 1996	Evaluation of Gradient Enhanced DNAPL Recovery in RWS-1 and RWS-2.
October 1996 – April 2006	Gradient Enhanced Operation in RWS-1, RWS-2, RWS-5 and RWN-4
April 2006	Lightning Strike Damages Groundwater Treatment System Controller
April 2006 - Present	Passive Recovery Operation in RWS-1, RWS-2, RWS-5 and RWN-4 with de minimis DNAPL Recovery

## 2.5 CONCEPTUAL SITE MODEL

A detailed presentation of the Conceptual Site Model (CSM) is included as Section 4.0 of the FSS. Summaries of the various components of the CSM are presented in the following subsections.

### **2.5.1 Site Geology and Hydrostratigraphy**

Extensive characterization of Site geology and hydrostratigraphy was conducted in the RI, subsequent pilot testing and remedial activities. The characterization was further developed through the more recent VGFTER (KEY/GWI 2000) and the Supplemental Groundwater Characterization (KEY/GWI 2006) efforts. Borehole information from investigations at the Site extends to depths of approximately 200 feet. Three water-bearing units are identified within this depth range, based on predominance of coarse grain sizes (e.g., sand or gravel). These units are referred to as the Shallow, Intermediate and Deep Zones. Data obtained during the RI demonstrated that constituents of interest in groundwater are limited to elevations well above the Deep Zone. Thus, subsequent efforts focused only on the Shallow and Intermediate Zones.

The Shallow and Intermediate Zones and the intervening Intermediate Aquitard are shown in cross-sections A-A' through B-B' provided as Figures 2-2 and 2-3, respectively. On these figures, a stipple pattern indicates material dominated by coarse grain sizes. Sand is shown as red stipple and gravel as orange. The stipple pattern is overlain by various hatch marks to denote the secondary presence of clay or silt.

#### **Shallow Zone**

As shown in the cross-sections, the bottom of the Shallow Zone typically occurs at between 18 to 21 feet below grade. An isopach map of the Shallow Zone sand is provided as Figure 2-4. This figure shows that the Shallow Zone sand is thinner in the Southern Area of the Site than it is in the Northern Area and the Shallow Zone pinches out completely in some off-Site areas to the west and southwest.

In the Northern Area, the Shallow Zone extends up to near the ground surface, although the upper portion is unsaturated. In the Southern Area, the Shallow Zone (where it is present) is typically overlain by a fine-grained layer dominated by clay.

The estimate of Shallow Zone hydraulic conductivity in the Northern Area was derived from a pump test for the Groundwater Collection Trench Pilot Study (McLaren/Hart, 1993):  $7.8 \times 10^{-3}$  cm/sec. The permeability of the Shallow Zone is lower in the Southern Area, where a pumping test completed as part of the Extraction Well Pilot Study indicated an average of  $1.6 \times 10^{-3}$  cm/sec (Keystone, 1992). This is consistent with the descriptions of the aquifer matrices documented on the boring logs which indicate, in general, the water-bearing zone in the Southern Area is poorly sorted and contains a greater percentage of fine-grained material relative to the water-bearing zone in the Northern Area.

#### **Intermediate Aquitard**

As shown in Figures 2-2 and 2-3, the Shallow Zone is immediately underlain by a continuous fine-grained layer consisting of materials ranging from clay to sandy clay. This layer is known

as the Intermediate Aquitard and is typically 30 feet thick and extends to depths from between 40 to 50 feet below grade.

The average vertical hydraulic conductivity of the Intermediate Aquitard is  $3 \times 10^{-8}$  cm/sec, as estimated from 12 laboratory tests conducted during the 1988 RI. These data indicate that the Intermediate Aquitard is a significant basal confining unit. Secondary features such as microfractures, “slickensides” and sandy or silty seams were noted within the upper portion of the Intermediate Aquitard, and they may increase the overall permeability of the unit. Nevertheless, the absence of drawdown in the Shallow Zone during pumping tests conducted in the Intermediate Zone indicates that the Intermediate Aquitard is a significant hydraulic barrier for groundwater flow between the Shallow and Intermediate Zones.

### **Intermediate Zone**

This unit is discontinuous across the Site. Where it occurs, it is situated between the two aquitards, as shown in Figures 2-2 and 2-3. Intermediate Zone thickness is shown in plan view in Figure 2-5. This unit is highly variable in thickness and it is absent across most of the Northern Area of the Site. Across much of the Southern Area, the Intermediate Zone is either absent or less than three feet thick. The aquitard underlying the Intermediate Zone is laterally continuous across the Site. It has a minimum thickness of approximately 40 feet, and typically extends to approximately 115 feet below grade.

Pumping tests conducted for the Extraction Well Pilot Study (Keystone, 1992) indicate that the hydraulic conductivity of the Intermediate Zone was similar in the Northern and Southern Areas of the Site, where present:  $3.9 \times 10^{-4}$  and  $3.2 \times 10^{-4}$  cm/sec, respectively. The conductivity of the aquitard underlying the Intermediate Zone is expected to be similar to that of the Intermediate Aquitard (i.e., approximately  $3 \times 10^{-8}$  cm/sec). Consequently, both the top and the bottom of the Intermediate Zone are highly confined.

### **2.5.2 Groundwater Flow Processes**

Groundwater flow in the Shallow and Intermediate zones, as well as the vertical flow of groundwater between the Shallow and Intermediate zones is discussed in this section.

#### **Groundwater Flow in the Shallow Zone**

The Shallow Zone water table occurs within a few feet below grade. A piezometric surface contour map of a recent Shallow Zone water level dataset is shown in Figure 2-6; these results are typical of historical data. The figure also summarizes the direction and magnitude of the water table gradient over the past several years. As indicated, the gradient direction is relatively consistent over time.

The predominant direction of groundwater flow in the Northern Area is almost due west. The average hydraulic gradient for the vectors shown on Figure 2-6 is 0.0039 feet/foot which

corresponds to an estimated average seepage velocity of 126 feet/yr (assuming a porosity of 0.25).

In the Southern Area of the Site, groundwater flows southwesterly. The average hydraulic gradient for the vectors shown on Figure 2-6 is 0.0042 feet/foot which corresponds to an estimated average seepage velocity of 28 feet/yr (assuming a porosity of 0.25).

### **Groundwater Flow in the Intermediate Zone**

Figure 2-7 is a piezometric surface contour map for a recent dataset from the Intermediate Zone. Groundwater flow in this unit is generally westerly, similar to the Shallow Zone. It is expected, however, that the lateral discontinuity of the Intermediate Zone causes some deformation of groundwater flow paths around areas where the unit is absent.

The groundwater seepage velocity is estimated at 14.85 ft/yr (4.5 m/yr) based on a typical gradient of 0.01 feet/foot (estimated from Figure 2-7), the average of the two Intermediate Zone conductivity estimates ( $3.6 \times 10^{-4}$  cm/sec), and an assumed effective porosity of 0.25.

### **Vertical Component of Groundwater Flow**

A downward vertical hydraulic gradient has been measured between the Shallow and Intermediate Zones, with potentiometric levels approximately 10 feet lower in the Intermediate Zone. The large differential in potentiometric surface elevations between the Shallow and Intermediate Zones is indicative of limited hydraulic connection between the two units. Given the typical thickness of the intervening Intermediate Aquitard (30 ft), the estimated hydraulic gradient across this unit is 0.33. Given the estimated average vertical hydraulic conductivity of this unit ( $3 \times 10^{-8}$  cm/sec) and an assumed effective porosity of 0.25, the groundwater seepage velocity across the Intermediate Aquitard is estimated to be 0.042 ft/yr (0.013 m/yr).

## **2.5.3 DNAPL Descriptive Information**

Information regarding the occurrence and distribution of DNAPL, as well as DNAPL fate and transport and historical DNAPL recovery operations are summarized in this section. Additional information is included in Section 4.4 of the FFS

### **Extent and Distribution of DNAPL**

The estimated extent of DNAPL (both free phase and residual) in the Shallow and Intermediate Zones is shown in Figures 2-8 and 2-9, respectively. Estimated DNAPL distribution in the Intermediate Aquitard is shown in Figure 2-10. These estimated footprints have been developed through several rounds of field work and desktop interpretation, as discussed in the FFS.

The following criteria were used to indicate the potential presence of subsurface DNAPL (either residual or free phase):

- Visual observation of DNAPL in soil borings;
- Measured DNAPL accumulation in groundwater wells (these wells are indicated on the Figures 2-8 and 2-9, and DNAPL observations are summarized in Table 2-1);
- Total polynuclear aromatic hydrocarbons (PAHs) greater than 100 mg/kg in soil;
- Total aromatic hydrocarbon concentrations greater than 1000 mg/kg in soil; and,
- Groundwater concentrations that approach the effective solubility of naphthalene in creosote (approximately 12 mg/L).

Although all of the listed criteria were evaluated, the delineation of DNAPL is primarily based on visual observations as a result of the large quantity of observation information available.

Comparison of the three source area figures indicates that the estimated DNAPL footprints are similar in the three units. In the Northern Area of the Site, the figures indicate two areas of potential DNAPL occurrence in all three zones. The northernmost occurrence generally corresponds to a former pond area. The second area is smaller and is located to the south.

Two areas of potential DNAPL occurrence are also delineated in the southern area, although they appear to be connected in the Intermediate Aquitard and Intermediate Zone. These areas correspond to the former wood treating process area near the southern Site boundary, and to the former coal tar plant along the eastern boundary.

### **Migration Potential of DNAPL**

No DNAPL movement has been observed at the Site either directly (via the accumulation of DNAPL in wells where it was not previously present), or indirectly (as evidenced by an increase in the contaminant plume size). No known releases of DNAPL have occurred at the Site since wood treating activities were discontinued in 1962, and much of the DNAPL was undoubtedly released many years prior to 1962. Given that several decades have passed since the most recent possible DNAPL release and based upon site conditions (i.e., relatively low permeability soils, lack of groundwater discharge to surface water in the vicinity of the Site and lack of a hydraulic driving force acting upon the DNAPL bodies), it is unlikely that additional DNAPL spreading will occur. Furthermore, evaluation of the upper surface of the Intermediate Aquitard shows that the surface is irregular and contains numerous stratigraphic traps (i.e., depressions in the aquitard surface) that would limit lateral migration of DNAPL.

Observational data obtained to date indicate that the DNAPL is immobile. Monitoring will be conducted to evaluate for DNAPL migration on an ongoing basis.

### **Long-Term Persistence of DNAPL**

The areas that contain residual or free phase DNAPL have persisted for the more than 45 years since wood treating operations ceased, and are expected to persist for many more decades. Source depletion occurs due to mass transfer from DNAPL to groundwater (i.e., dissolution), and then subsequent migration and natural attenuation in downgradient zones. Consequently, source zone persistence is primarily due to mass transfer limitations, including the following:

- Creosote and coal tar constituents have relatively low solubility limits; as groundwater becomes saturated to the solubility limit of the individual compound, mass transfer from the DNAPL to the groundwater stops;
- The overall permeability of the source zone is low, which limits groundwater velocity and the removal of mass from the source area;
- Groundwater flow is negligible through some source areas, due to natural heterogeneity; removal of mass from these low flow areas occurs through diffusion, which is a slow process; and,
- As isolated source areas start to become depleted, the rate of mass transfer slows even more, leading to a “tailing effect”.

A conservative estimate (i.e., likely an underestimate) of source persistence is illustrated in the FFS. Naphthalene was used as an example compound because it is one of the more mobile of the coal-tar DNAPL constituents. The use of naphthalene as an example compound introduces conservatism because it is more soluble than most creosote compounds. The time required to deplete the naphthalene across the source zone was estimated to be more than 170 years.

#### **2.5.4 Dissolved Phase Constituent Information**

Information regarding the occurrence and distribution of dissolved phase constituents and a summary of evidence of natural attenuation processes is provided in this Section. The development of, and justification for, the conclusions can be found in Section 4.5.1 of the FFS.

The COIs identified in groundwater at the Site are typical of creosote wood treating sites: PAHs and benzene, toluene, ethylbenzene and xylenes (BTEX). The source of COIs in groundwater are those areas where DNAPL (primarily residual with some free product) has been observed in the Shallow and Intermediate Zones.

## **Extent and Distribution of Dissolved Phase Constituents**

Information presented in the FFS show that COI concentrations are most pronounced within and immediately downgradient of the source zone. Assessments done as part of the GFTER show that the distribution of dissolved phase constituents is limited by natural attenuation (physical, chemical, and biological processes) as discussed in the following section.

## **Fate and Transport of Dissolved Phase Constituents (Natural Attenuation)**

The evaluation of the fate and transport of dissolved phase constituents at the Site began with the Groundwater Fate and Transport Evaluation Report (GFTER; KEY 1997), which was a desktop assessment using data available at the time. The GFTER concluded that natural attenuation was occurring in the Shallow Zone and that additional field evaluation was warranted to verify this conclusion.

The additional field work was undertaken and reported in the Verification of the Groundwater Fate and Transport Evaluation Report (VGFTER; 2000). The VGFTER concluded that MNA is a feasible remedy for dissolved phase COIs in Shallow Zone groundwater.

In 2005, additional field work was conducted to determine if preferential pathways exist at the Site that could cause accelerated COI migration, and decreased natural attenuation potential. This investigation (Supplemental Groundwater Investigation Report, KEY March, 2006) addressed both the Shallow and Intermediate Zones. It concluded that significant preferential pathways do not exist and supported the earlier recommendations of the VGFTER for incorporation of MNA into the Site groundwater remedy. Also, the investigation provides the basis for the conclusion that an MNA remedy is also appropriate for the Intermediate Zone.

A general conceptual model for natural attenuation on wood treating sites is provided in Appendix A of the FFS Report. To evaluate natural attenuation at the Site, various types of evidence were considered versus expected trends as outlined in the general conceptual model. The lines of evidence evaluated are outlined in Section 4.5.2 of the FFS and the approach is consistent with the EPA (EPA OSWER 1999) and TCEQ (TNRCC 2001) MNA protocols.

Natural attenuation at the Site was initially evaluated in the GFTER (KEY 1997), then updated in the VGFTER (KEY/GWI 2000), the Supplemental Groundwater Characterization (KEY/GWI 2006), and the FFS Report (KEY 2007). They are summarized as follows:

***COI Trends*** – COI concentration trends are consistent with natural attenuation. Over a 22 year period, COI concentrations (as represented by benzene and naphthalene) remained stable or decreased at 37 of 38 (over 97%) of the monitoring well locations. Note that the single well where a decrease was not observed is located within the source area and DNAPL has been observed in samples collected from this well in the past.

***Natural Attenuation Indicator Parameter Trends*** - These were assessed for parameters that included electron acceptors, metabolic by-products, oxidation reduction potential, and microbial indicators. They provide qualitative evidence that COIs are biodegrading at the Site.

***Analytical Plume Modeling*** - The results indicated that the dissolved phase distributions were stable and would not advance further. They are consistent with the COI trends previously discussed.

A Technical Memorandum (KEY 2011) has been prepared to document the comprehensive evaluation of the natural attenuation (NA) processes occurring at the Site. This evaluation provides a basis for deciding if a MNA program can be an effective groundwater remedy for the Site.

### **2.5.5 Potential for Exposure**

This section presents information to demonstrate that there is currently no exposure to impacted groundwater at the Site or in the vicinity of the Site. It also presents an evaluation of potential future exposure and methods to ensure and verify that future exposure potential remains negligible. The information presented below is a summary of the information presented in Section 4.6 of the FFS.

#### **Current Conditions**

On-Site property owners are prohibited from installing groundwater production wells on their properties by virtue of the January 24, 1992 Administrative Order on Consent with the United States and corresponding settlement/access agreements with Beazer. Thus, there is no potential for exposure to groundwater by on-Site workers. Groundwater in the shallow and intermediate zones is not currently being used in the vicinity of the Site for any purpose.

#### **Future Conditions**

The potential for off-Site future use of groundwater in the Shallow and Intermediate Zones is negligible for the following reasons:

- Water in the local area is supplied by the municipal system and evaluation done as part of the VGFTER showed that use of water from the municipal supply is more cost-effective than the installation and operation of a private well;
- The quality of shallow groundwater is marginal as a result of naturally-occurring conditions. Background iron and manganese concentrations in groundwater exceed drinking water criteria;
- Groundwater yield from the Shallow and Intermediate Zones is expected to be low based on observations during pumping tests and DNAPL recovery operations; and,

- The industrial land use throughout much of the local area, and the overall urban setting would dictate against the development of shallow groundwater supplies, due to a wide range of potential water quality concerns.

### **Prohibition on Groundwater Use (Institutional Controls)**

Beazer will establish Institutional Controls (ICs) to preclude the use of groundwater in the TI zone. Several options are available for establishing groundwater use ICs. It is anticipated that the necessary ICs can be established within two years of the effective date of the ROD Amendment. The options for establishing the ICs include:

**Restrictive Covenant** – If a property owner consents after receipt of written notice from Beazer, a groundwater use IC can be implemented via a restrictive covenant filed in the real property records of the county where the property is located. The restrictive covenant would remain in effect into perpetuity, would provide a warning against the use and/or exposure to groundwater within the TI zone, and would be binding upon all future property owners.

**Municipal Settings Designation** – In September 2003, the Texas State Legislature amended the Texas Health and Safety Code to authorize Municipal Settings Designations (MSD). The MSD program allows municipalities in Texas to designate areas where groundwater cannot be used for potable purposes. The City of Houston passed an ordinance allowing the City to participate in the MSD program on August 22, 2007. Beazer would be responsible for preparing the MSD application for submission to the City. Once the City has reviewed and approved the MSD application, the application must be submitted to the TCEQ for review and approval.

**Court Resolution for Authority to File Deed Notice** – The TRRP provides a mechanism for placement of restrictive covenants without landowner consent in the case of technical impracticability of meeting residential-based PCL within the TI zone.

### **Verifying No Future Groundwater Use**

The Houston-Galveston Coastal Subsidence District (HGCSD) has adopted a series of regulatory plans to reduce groundwater pumping. A summary of these regulatory plans can be found in Section 4.6.3 of the FFS. As a precautionary measure, the HGCSD well registration process can be utilized as a mechanism to notify Beazer and the agencies of any future well installations in the area.

## **2.6 FOCUSED FEASIBILITY STUDY SUMMARY**

Remedial action objectives (RAOs), as defined for the Site in the Section 5.4 of the FFS, are presented in this Section. It also summarizes the remedial alternative evaluation and selection process described in Sections 6.0, 7.0 and 8.0 of the FFS.

### **Remedial Action Objectives**

The approach used to define Site RAOs in the FFS was consistent with USEPA's TI policy, USEPA's July 31, 1995 directive, and the TRRP. The RAOs consider Site conditions and constituent characteristics, and are as follows:

- Prevention of dissolved phase plume migration beyond current limits; and,
- Prevention of future exposure to impacted groundwater.

The first RAO is currently achieved, as indicated by stability of the dissolved phase groundwater plume through natural attenuation processes. Ongoing compliance with this RAO can be demonstrated by implementation of a long term groundwater monitoring plan.

The second RAO can be accomplished by periodic verification of incomplete exposure pathways for groundwater. If necessary, the institutional control process established within the TRRP may be utilized to ensure that exposure to impacted groundwater does not occur.

### **Description of Remedial Alternatives**

As a result of discussions between Beazer, USEPA, and TCEQ, the following remedial alternatives were evaluated in the FFS:

- No Further Action
- Monitored Natural Attenuation with No Further Action for Source Zone
- Monitored Natural Attenuation with Continued Source Removal
- In-Situ Solidification/Stabilization (S/S) of Accessible Source Materials

These alternatives were described in Section 6.0 of the FFS. In Section 7, they were evaluated against the nine criteria specified in the National Contingency Plan (NCP). Table 2-2 provides summarizes of the results of the remedial alternative evaluation process.

### **FFS Conclusions and Recommendations**

The FFS conclusions and recommendations for a future modified groundwater remedy were presented in Section 8.0 of the FFS Report and are summarized herein.

As indicated in Table 2-2, each of the alternatives, including the No Further Action alternative, is considered protective of human health and the environment. The primary discriminating factors between the various alternatives are the following:

- Compliance with ARARs
- Community Acceptance
- State Acceptance
- Cost

The No Further Action alternative is not considered entirely compliant with ARARs because it includes no provisions for monitoring as suggested by the TRRP. The use of a disruptive alternative (i.e., in-situ solidification/stabilization) is expected to be objectionable to community business owners and others at and in the vicinity of the Site. By contrast, no major shortcomings can be identified for either of the two MNA alternatives. Both of these alternatives are expected to provide for continued protection of human health and the environment.

Source control measures implemented over the last decade have been shown to be of no benefit at the Site. Consequently, it was recommended in the FFS that the MNA with No Further Action for Source Zone alternative be pursued as the preferred alternative for the Site. A TI Waiver will be established to waive ARARs for groundwater within the potential source areas and dissolved phase plumes (i.e., collectively, the TI Zones). Institutional controls in the form of a groundwater use prohibitions will also be established for the TI Zones.

### 3.0 TECHNICAL IMPRACTICABILITY EVALUATION

#### 3.1 JUSTIFICATION FOR TI DECISION

The justification for a TI Decision is presented in this Section. In addition, to the three criteria specified in EPA's TI Guidance (hydrogeologic factors, contaminant related factors and technological factors), two other site-specific criteria (land use considerations and exposure potential considerations) are evaluated.

##### 3.1.1 Hydrogeologic Factors

The hydrogeologic conditions at the Site are consistent with the impracticability of remediation of impacted groundwater to achieve groundwater quality ARARs within a reasonable time frame. The EPA's TI Guidance Document (EPA 1993) indicates that hydrogeologic conditions favoring a TI decision include complex geology (interbedded and discontinuous strata), low permeability units and heterogeneity. As indicated previously, the Shallow and Intermediate Zones are comprised of a heterogeneous and complex system of interbedded sands, silts and clays. The Shallow and Intermediate Zones are separated by a micro-fractured clay unit (referred to as the Intermediate Aquitard) which inhibits but does not completely preclude hydraulic connection between the two units. The predominance of fine-grained sediments has resulted in relatively low permeabilities for the water-bearing zones of interest ( $10^{-3}$  to  $10^{-4}$  cm/s). While these conditions are favorable for limiting the extent of dissolved plume migration, they are detrimental to the removal of source material and the dissolved constituents derived there from in a reasonable time frame either by physical removal or dissolution and subsequent natural degradation. Furthermore, it is noted that the intervening Intermediate Aquitard also contains a substantial quantity of source material. The removal of this material would be even more difficult.

The effective physical removal of mass is precluded not only by the low permeability of the water-bearing zones but also by the limited saturated thickness of these units. As a result of these conditions, the maximum sustainable groundwater yields are only one gallon per minute or less. Given that the viscosity of a creosote/coal tar DNAPL is much greater than groundwater, it is clear that it is not practicable to recover significant quantities of DNAPL in a reasonable timeframe in spite of proper system design and best efforts to remove it from the subsurface. Because of its high viscosity, creosote/coal tar will move at only very small percentage of the groundwater flow rate. If hydrogeologic conditions are such that only a very small quantity of groundwater can be produced then it follows that very small creosote/coal tar recovery rates should be expected.

The site hydrogeologic conditions are also responsible in part for the preponderance of residual DNAPL at the Site (i.e., non-recoverable DNAPL that is present at levels below its residual saturation). Residual DNAPL saturations will be greater in fine-grained heterogeneous

formations as opposed to coarse grained and homogeneous units. Where DNAPL does exist at levels above its residual saturation, only a fraction of the source material can be removed. The remainder of the DNAPL will persist as residual and continue to act as a source of dissolved phase COIs for an extended length of time.

The dissolution of a creosote source into groundwater is an extremely slow process due to the extremely low effective solubilities of the individual constituents. These values are summarized in Table 3-1. The hydrogeologic conditions at the Site compound this effect. In addition to the low permeability of the aquifer, the relatively flat horizontal hydraulic gradient results in relatively low horizontal groundwater velocities. As demonstrated in the FFS, these combined effects result in a contaminant source that will persist for well over 100 years regardless of whether the recovery system continues to operate or not.

A significant percentage of the source material mass is contained within the micro-fractured Intermediate Aquitard which separates the Shallow and Intermediate water-bearing zones. A downward vertical hydraulic gradient exists across this unit. Thus, the DNAPL trapped within this unit has the potential to act as a long-term source of dissolved COIs to underlying Intermediate Zone.

### **3.1.2 Contaminant-Related Factors**

The contaminant-related factors are also consistent with the impracticability of the remediation of impacted groundwater to achieve groundwater quality ARARs within a reasonable time frame as described below.

- The NAPLs at the Site are creosote and coal tar which are slightly denser than water. This attribute makes it extremely difficult to precisely locate the source material and remediate groundwater in a cost-effective manner, especially in complex heterogeneous geologic systems such as those at the South Cavalcade Site. The combined effect results in the distribution of DNAPL over a broad area, although the mass in any given porous media volume is relatively small.
- A significant fraction of the source material exists as non-recoverable residual DNAPL. The residual DNAPL is immobile even under extreme hydraulic gradient conditions as a result of capillary tension in the soil. The residual DNAPL left behind will persist for many decades as a source of dissolved constituents.
- Creosote and coal tar are much more viscous than groundwater (by an order of magnitude or more). The high viscosity of the DNAPL significantly inhibits its mobility in the subsurface and the ability to remove of significant quantities of DNAPL within a reasonable time. This effect is exacerbated by the heterogeneous and low permeability aquifer materials beneath the Site.

- The limited effective solubilities of creosote and coal tar constituents prevent removal of significant mass via groundwater extraction. The water soluble fraction of creosote or coal tar represents less than 0.01% of the total mass of source material.
- PAHs in general are not amenable to accelerated biodegradation, are non-volatile, and exhibit a great degree of sorption. All of these factors make remediation to MCLs or other standards throughout the Site via active means impracticable.

### 3.1.3 Design and Operations Considerations

The EPA's TI Guidance identifies inadequate remedial system design and implementation as a factor that may inhibit groundwater restoration. The purpose of this subsection is to document the proper design and implementation of the DNAPL recovery system.

As discussed in the 100% Design Report for the DNAPL Recovery System and Groundwater Collection System (McLaren/Hart, 1994), the DNAPL recovery wells were placed in the areas with potentially recoverable DNAPL (i.e. former process areas, areas where measurable thicknesses of DNAPL had been identified) and at locations corresponding to topographically low points in the upper surface of the basal confining unit. Thus, the DNAPL recovery wells were installed at optimal locations to remove any readily recoverable DNAPL. In making this determination, the following information was evaluated during the RD:

- The locations of former plant process areas (i.e., wood treatment area, coal tar distillation area, tar farm areas, surface impoundment);
- The configuration of the basal aquitard for the shallow groundwater-bearing zone;
- Observations of DNAPL as noted on Site boring logs;
- Measurement of DNAPL in Site monitoring wells; and,
- Soil and groundwater analytical data.

Each well was constructed of six-inch diameter stainless steel screen and riser. Stainless steel was chosen as the well construction material because it is resistant to degradation and damage from the creosote and coal tar DNAPLs. The screen sections are continuous wrap design with 0.020-inch width slots. The gradation of the filter pack placed in the annulus surrounding the well screen was designed based upon the grain size analysis of the aquifer matrix to maximize well efficiency. Each well was installed with a three foot long solid-wall sump at the base of the well to allow for the accumulation of DNAPL that entered into the recovery well. The top of the sump/base of the well screen was placed at an elevation below the contact between the shallow water-bearing zone and the Intermediate Aquitard.

Initially, passive DNAPL recovery was attempted. In 1996, the wells began operating in an enhanced recovery mode (i.e., with groundwater pumping). DNAPL recovery in the gradient enhanced mode continued until April 2006, at which time the treatment system controller was disabled as a result of an electrical power surge which likely resulted from a lightning strike. Since then, the wells have operated in passive mode (i.e., without groundwater pumping) with EPA and TCEQ approval.

The DNAPL recovery system was operated in the gradient enhanced mode for approximately 10 years. During this period, the system operated continuously except for periodic interruptions for routine maintenance and infrequently for repair or replacement of equipment. Each well was equipped with high level and low level pump control switches to ensure that the groundwater extraction rates were maximized and that the drawdown in the pumping wells was maintained within an optimum range to produce a maximum hydraulic gradient toward the recovery well. DNAPL was removed from the sump before the DNAPL accumulated to the elevation of the top of sump/bottom of the well screen. Over time the DNAPL recovery rates were observed to decrease from approximately 1.92 gallons per day (gpd) to 0.84 gpd in spite of the fact that groundwater removal rates and hydraulic gradients toward the recovery well were maximized. Thus, it is concluded that the DNAPL recovery system operations have reached a point of diminishing returns and further DNAPL removal is impracticable.

### **3.1.4 Land Use Considerations**

The active and disruptive types of remedial operations that would have to be done on-site to achieve ARARs are not deemed practicable for the following reasons:

- As described in EPA's April 23, 2008 Technical Memorandum titled *Supporting Arguments for Proposed Remedial Alternative* (EPA 2008), implementation of an intrusive remedy such as excavation or in-situ solidification/stabilization in the on-site source areas would have an extremely detrimental effect on the businesses operating at the Site since the majority of the target areas are used for truck traffic and parking and are thus impracticable. In addition, such remedies would require the destruction and reconstruction of the completed soil remedy.
- In situ remedies that involve the injection of reactants would not be practicable because, due to the size of the source areas and mass contained therein, an unrealistically high number of injection points would be required for complete coverage and an untenable quantity of reactant would be required for full treatment. In addition, if such a system would be constructed, the treatment areas would have to be restricted in terms of use by the businesses operating at the Site to allow for operations, maintenance and monitoring.
- The planned construction of the Hardy Toll Road extension makes the operation of a remedial system in the downgradient areas off-site impracticable.

In summary, land use considerations also favor a TI Decision when considered in conjunction with the other TI Justification Criteria. On-site remedial measures would greatly inhibit the ability of the on-Site businesses to operate. Such disruption is not necessary in this instance because of the lack of current exposure to impacted groundwater and the negligible potential for exposure to occur in the future.

### **3.1.5 Exposure Considerations**

As indicated above, groundwater in the shallow and intermediate zones is not currently being used for any purpose in the vicinity of the Site. There is no potential for future on-site groundwater use because Site property owners are prohibited from installing groundwater production wells on their properties by virtue of their respective Consent Orders with the United States and corresponding settlement/access agreements with Beazer. The potential for future groundwater usage in the area was evaluated in detail in Section 4.6 of the FFS. The conclusion drawn from this evaluation was that the potential for exposure to impacted groundwater in the area surrounding the Site is extremely remote for the following reasons:

- Water from the public supply is readily available in the area surrounding the Site and is more cost effective than utilizing groundwater as a source of water;
- The natural quality of shallow groundwater in the vicinity of the Site is poor due to elevated concentrations of naturally occurring constituents such as iron and manganese;
- The planned extension of the Hardy Toll Road will further isolate the Site from the residential area to the west;
- The industrial land use throughout much of the local area, and the overall urban setting would dictate against the development of shallow groundwater supplies, due to a wide range of potential water quality concerns;
- The deeper more productive aquifers are not impacted and future impact is prevented by the existence of thick and continuous confining units;
- The nearest discharge point for groundwater to surface water is more than  $\frac{3}{4}$  of a mile from the Site;
- Natural attenuation is occurring and applicable standards are attained within a short distance of the source areas; ongoing protectiveness would be confirmed by long term monitoring; and,
- The shallow aquifer cannot sustain an extraction rate of more than 2 gallons per minute thus precluding commercial or industrial shallow groundwater use which typically has much greater production demands.

Given that there is no current exposure to impacted groundwater and the potential for future use is negligible, exposure considerations strongly favor a TI Decision. One or a combination of the available institutional control options described in Section 2.5.5 will be utilized for establishing prohibitions on groundwater use within the TI Zones. As a precautionary measure, the HGCSD well registration process can be utilized as a mechanism to notify Beazer and the agencies of any future well installations in the area.

### **3.2 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS)**

Various sets of water quality standards were identified within the ROD as ARARs and some were used as the basis for the numeric concentration-based groundwater remedial goals. These ARARs were evaluated in Section 5.3 of the FFS. The ARARs for which a waiver is sought include Federal and State groundwater quality criteria and ROD standards. Specifically, the ARARs for which waivers are sought include:

- Protective Concentration Levels for groundwater specified in the Texas Risk Reduction Program Rule (30 TAC 350);
- National Primary and Secondary Drinking Water Standards;
- Maximum Contaminant Level Goals;
- Groundwater Remedial Goals specified in the ROD; and
- A waiver of these ARARs is sought within the TI Waiver Zones in support of this TI demonstration.

Appendix A includes a compilation of these ARARs.

### **3.3 PROPOSED TI WAIVER ZONES**

The limits of the proposed TI Waiver Zones for the Shallow Zone and Intermediate Aquitard/Zone are shown on Figures 3-1 and 3-2, respectively. Separate TI Waiver zones have been proposed for the North Area and South Area plumes. The limits of the proposed TI Waiver Zones will be established such that areas where DNAPL exists and ROD Standards and Federal and State groundwater standards are exceeded are included in the proposed TI Waiver Zone. The delineated source zones and groundwater analytical data for benzene and naphthalene are also shown for justification of the proposed TI Waiver Zone limits. Groundwater use prohibitions will be established to prevent future use of groundwater within the TI Waiver Zone once it is established.

Groundwater monitoring will be conducted to demonstrate that the dissolved COIs remain entirely within the established TI Waiver Zones. Existing monitoring wells or monitoring wells to be installed in the future will serve as sentinel wells to detect any advancement of the dissolved plume front or any increase in concentrations within the core of the plume. A

preliminary proposed monitoring plan is outlined in the Natural Attenuation Technical Memorandum. The proposed monitoring plan will be presented in the Proposed Plan.

### **3.4 RESTORATION POTENTIAL**

#### **3.4.1 Source Delineation and Control**

As indicated by the following discussion, the nature and extent of the DNAPL source material at the Site has been successfully delineated and no significant migration of the source material has been observed and is extremely unlikely to occur in the future. The extent of DNAPL (both free phase and residual) in the Shallow and Intermediate Zones is shown in Figures 2-8 and 2-9, respectively. Estimated DNAPL distribution in the Intermediate Aquitard is shown in Figure 2-10. These estimated footprints have been developed through several rounds of field work and desktop interpretation, as discussed in the FFS.

The following criteria were used to indicate the potential presence of subsurface DNAPL (either residual or free phase):

- Visual observation of DNAPL in soil borings;
- Measured DNAPL accumulation in groundwater wells (these wells are indicated on Figures 2-8 and 2-9, and DNAPL observations are summarized in Table 2-1);
- Total PAHs greater than 100 mg/kg in soil;
- Total aromatic hydrocarbon concentrations greater than 1000 mg/kg in soil; and,
- Groundwater concentrations that approach the effective solubility of naphthalene in creosote (approximately 12 mg/L).

Comparison of the three source area figures indicates that the estimated DNAPL footprints are similar in the three units. In the Northern Area of the Site, the figures indicate two areas of potential DNAPL occurrence in all three zones. The northernmost occurrence generally corresponds to a former pond area. The second area is smaller and is located to the south.

Two areas of potential DNAPL occurrence are also delineated in the southern area, although they appear to be connected in the Intermediate Aquitard and Intermediate Zone. These areas correspond to the former wood treating process area near the southern Site boundary, and to the former coal tar plant along the eastern boundary.

No known releases of DNAPL have occurred at the Site since wood treating activities were discontinued in 1962, and much of the DNAPL was undoubtedly released many years prior to 1962. Site characteristics (i.e., relatively low permeability soils, the presence of stratigraphic traps, lack of groundwater discharge to surface water in the vicinity of the Site and lack of a hydraulic driving force acting upon the DNAPL bodies) are also favorable conditions for promoting DNAPL stability. These observations are straightforward indications that the DNAPL

distributions at the Site are likely to be stable. As discussed in Section 3.4.2 of this report, DNAPL recovery operations at the Site have removed an inconsequential portion of the total mass of DNAPL present and consequently, it is not believed that such recovery has a significant effect on controlling potential DNAPL movement. In spite of this, no DNAPL movement has been observed either directly (via the accumulation of DNAPL in downgradient wells), or indirectly (as evidenced by an increase in the contaminant plume size).

### 3.4.2 Performance of Remedial Measures

The purpose of the following evaluation of the remedial measures performance is to determine whether attainment of remedial goals can be achieved within a reasonable timeframe through continued operation of the system. As indicated in the FFS, the DNAPL recovery rate has noticeably decreased over the duration of the gradient-enhanced DNAPL recovery operations, as illustrated in Figure 3-3. The maximum recovery rate (approximately 1.92 gpd) occurred in 1998 and 1999. The rate subsequently decreased to approximately 1.05 gpd, and was approximately 0.84 gpd in recent years. This trend indicates a diminishing return, in terms of the effort per unit volume of DNAPL recovered. It is further noted that a significant portion of the DNAPL is present at levels below residual saturation. This residual DNAPL is unrecoverable by gravity drainage and will be retained in the formation by capillary tension.

A summary of DNAPL and groundwater recovery as of June 2008 is provided below:

<i><b>DNAPL Recovery Well</b></i>	<i><b>Total DNAPL Recovered (gal)</b></i>	<i><b>Percent of Total DNAPL Recovered</b></i>	<i><b>Groundwater Pumping Rate (gpm)</b></i>
RWS-1	1,840	45.8	0.3
RWS-2	355	8.8	0.3
RWS-5	90	2.2	1
RWN-4	1,731	43.1	0.3
<b>TOTAL</b>	<b>4,016</b>	<b>100</b>	<b>1.9</b>

As indicated in the FFS, the total volume of DNAPL in the source zones is estimated at 242,381 gallons. The volume of DNAPL recovered at the Site over an eleven year period (4,016 gal) represents approximately 1.7% of the total DNAPL volume.

In spite of the best efforts, the system was not effective for removing a significant volume of DNAPL due to the following factors:

- DNAPL physical characteristics (low density and high viscosity);
- hydrogeologic factors (low permeability and limited saturated thickness); and,

- DNAPL distribution factors (only a very small percentage of the total estimated mass could be removed in over 11 years of operation).

On the basis of this evaluation, it is concluded that the DNAPL recovery program has not removed, and is not expected to remove, any significant fraction of the source within a reasonable timeframe.

The DNAPL recovery operation produces negligible continuing environmental benefit and has reached a point of diminishing returns (i.e., DNAPL has been removed to the maximum extent practicable). Continued pumping of the groundwater and associated DNAPL recovery operations are expected to have an insignificant impact on migration of, extent of, and exposure potential for dissolved phase COIs in groundwater. Both human health and the environment will continue to be protected even if operation of the gradient-enhanced DNAPL recovery system is discontinued.

### **3.4.3 Restoration Timeframe Analysis**

A restoration timeframe analysis was presented for the natural attenuation of naphthalene in Section 4.4.3 of the FFS. Based on this analysis, it was estimated that over 170 years would be required to achieve the groundwater quality standard for naphthalene via natural attenuation. Thus, restoration of the aquifer within a reasonable time frame is not practicable. As indicated above, after 11 years of DNAPL recovery, only a very small percentage (less than 2%) of the DNAPL mass has been removed. Thus, it is evident that the restoration timeframe cannot be significantly reduced via continuation of the DNAPL recovery efforts. As the majority of the DNAPL present at the Site cannot be recovered, the dissolution of the source, which is severely limited by Site-specific hydrogeologic and contaminant-related factors, is the limiting factor the restoration of groundwater within a reasonable timeframe.

### **3.4.4 Other Remedial Approaches**

DNAPL exists within the Shallow Zone, Intermediate Aquitard and Intermediate Zone. As a result of the presence of DNAPL (creosote and coal tar), restoration of groundwater throughout the Site to comply with ARARs within a reasonable time frame is not practicable by currently available conventional or innovative technologies as demonstrated by the following:

- The majority of the DNAPL exists below the water table and extends to depths as great as 60 feet below ground surface. Therefore, the source material cannot be physically removed by excavation.
- Complete removal of DNAPL by pumping is physically impossible. A substantial fraction of the DNAPL will remain as immobile residual which will continue to act as a source of dissolved constituents for well over 100 years.

- In situ treatment of the source materials is also not practicable due to site geologic factors (low permeability, heterogeneity), volume and mass of source material (DNAPL), source mobility and dissolution limitations and site land use considerations.

Based on the above, the following remedial alternatives were evaluated in the FFS:

- No Further Action
- Monitored Natural Attenuation with No Further Action for Source Zone
- Monitored Natural Attenuation with Continued Source Removal
- In-Situ Solidification/Stabilization (S/S) of Accessible Source Materials

As described in Section 2.6 of this report, it was recommended in the FFS that the MNA with No Further Action for Source Zone alternative be pursued as the preferred alternative for the Site. The capital costs of implementing this alternative are \$42,000, which includes installation of seven additional monitoring wells. The operation and maintenance costs for the 30 year MNA program implementation period are \$910,000. Consequently, the present worth of this alternative is approximately \$952,000.

### **3.5 CONTINGENCY REMEDIAL MEASURES**

If groundwater monitoring results demonstrate that the RAOs are not being attained, EPA and TCEQ will be promptly informed and a meeting will be scheduled to discuss additional evaluations to be performed to determine if implementation of a contingency remedial measure is warranted, and if so, to develop and evaluate potential measures. The types of measures to be evaluated will be dependent upon the circumstances causing the non-attainment of the RAO's and may include, but are not necessarily limited to, expansion of institutional controls, physical barriers and enhanced natural attenuation. Additional information regarding potential contingency measures will be provided in the EPA's upcoming Proposed Plan.

## 4.0 CONCLUSIONS

The applicability of a TI Waiver for groundwater ARARs at the South Cavalcade Site was evaluated relative to the three criteria specified in EPA's TI Guidance (hydrogeologic factors, contaminant related factors and technological factors), two other site-specific criteria (land use considerations and exposure potential considerations). Without exception, all criteria favor the decision to establish a TI Waiver for groundwater ARARs at the Site as described below:

**Hydrogeologic Factors** – The Site is underlain by a series of predominantly fine-grained interbedded heterogeneous sediments which makes the remediation to groundwater quality standards impracticable and limits the rates at which the mass of the source material can be depleted or removed.

**Contaminant-Related Factors** – The source materials are DNAPLs comprised of creosote and coal tar. Regardless of the best efforts to remove all recoverable DNAPL, a significant mass of unrecoverable residual DNAPL will remain in the subsurface and serve as a source of dissolved phase impacts for over 100 years due to the limitations in the rate of dissolution.

**Design and Operations Considerations** – The recovery wells were placed in locations that were determined to be most favorable for DNAPL recovery. The wells were designed to maximize well efficiency and operated to maximize the induced hydraulic gradient toward the well. In spite of the proper selection of recovery well locations, well design and system operation, the DNAPL Recovery System operated in a gradient enhanced mode for approximately 10 years and was only able to remove an estimated 1.7% of the total DNAPL mass.

**Land Use Considerations** – Any active remedy designed to achieve groundwater ARARs could not be implemented without serious disruption or termination of ongoing business operations at the Site. Given the lack of current or potential exposure to impacted groundwater, such aggressive measures are not necessary.

**Exposure Considerations** – There is no current exposure to groundwater. The potential for future exposure is extremely unlikely. Groundwater use prohibitions will be established to ensure that no exposure to impacted groundwater occurs in the future.

As concluded in the FFS, an MNA remedy with no further source removal is considered protective of human health and the environment. Based on the evaluations presented herein, it is recommended that a TI Waiver for groundwater ARARs for the Site be established to support the implementation of the monitored natural attenuation groundwater remedy. Should groundwater monitoring data indicate that the RAOs are not being met, an evaluation of the need for contingency remedial measures will be undertaken and, if determined necessary, potential contingency remedial alternatives will be developed, evaluated and the preferred alternative implemented.

## 5.0 REFERENCES

Key Environmental, Inc., 1997, *Groundwater Fate and Transport Evaluation Report*

Key Environmental, Inc., 2000, *Verification of Groundwater Fate and Transport Evaluation Report.*

Key Environmental, Inc., 2006, *Supplemental Groundwater Characterization Report.*

Key Environmental, Inc., 2008, *Focused Feasibility Study Report.*

Keystone Environmental Resources, Inc., 1992, *Extraction Well Pilot Study Report.*

McLaren/Hart Environmental Engineering Corporation, 1993, *100% Remedial Design - DNAPL Recovery System and Groundwater Collection System.*

McLaren/Hart Environmental Engineering Corporation, 1993, *Groundwater Collection Trench Pilot Study Report:*

Texas Natural Resource Conservation Commission, 2001, *Monitored Natural Attenuation Demonstrations* RG-366/TRRP-33

U.S Environmental Protection Agency, September 1993 Guidance Document titled *Guidance for Evaluating the Technical Impracticability of Ground-Water Restoration.* Publication No. 9234.2-25, EPA/540-R-93-080 PB93-963507.

U.S, Environmental Protection Agency - Office of Solid Waste and Emergency Response, 1999, *Use of Monitored Natural Attenuation at Superfund RCRA Corrective Action and Underground Storage Tank Sites*, Directive No, 9200.4-17P

U.S Environmental Protection Agency, April 23, 2008, *Technical Memorandum - Supporting Arguments for Proposed Remedial Alternative (i.e., Monitored Natural Attenuation with No Further Action for Source Zone) at the South Cavalcade Superfund Site, Houston, Texas.*

## **TABLES**

**TABLE 2-1**  
**DNAPL THICKNESS MEASUREMENT SUMMARY**  
**TECHNICAL IMPRACTICABILITY DEMONSTRATION**  
**SOUTH CAVALCADE SUPERFUND SITE**  
**HOUSTON, TEXAS**

Well	DNAPL Thickness (ft)			Date of Most Recent	Comments
	Minimum	Maximum	Most Recent		
SHALLOW ZONE WELLS					
RWS-1	0	10.93	0.02	12/18/2006	
RWS-2	0	3.59	2	12/18/2006	
RWN-4	0	11	0	8/30/2006	
RWS-5	0	2.73	0.05	11/29/2006	
PZS-10	0	6.67	0	10/17/2006	
PZS-20	0.083	13	3.96	10/17/2006	
PZN-40	0	-	0	10/17/2006	DNAPL noted during historical groundwater sampling
PZN-41	0	-	0	10/17/2006	DNAPL noted during historical groundwater sampling
PZS-50	0.08	0.62	0.26	10/17/2006	
PZS-51	0	0.25	0	10/17/2006	
OW-02	0	2.42	0.07	10/17/2006	
OW-10	0	-	0	10/17/2006	DNAPL noted during historical groundwater sampling
OW-11	0.683	0.98	0.1	10/17/2006	
P-02N	-	0.8	0.8	9/17/2005	One available measurement
MW-06	0	3	0	9/17/2005	
INTERMEDIATE ZONE WELLS					
OW-20	-	1.27	1.27	9/16/2005	One available measurement
MW-12R	-	2	2	9/17/2005	One available measurement
ITW-02	-	2.4	2.4	9/17/2005	One available measurement

**TABLE 2-2**  
**REMEDIAL ALTERNATIVE EVALUATION SUMMARY**  
**TECHNICAL IMPRACTICABILITY DEMONSTRATION**  
**SOUTH CAVALCADE SUPERFUND SITE**  
**HOUSTON, TEXAS**

Alternative	Description	Evaluation Criteria								
		Protective of Human Health and the Environment?	Compliant with ARARS?	Effective and Permanent over the Long-Term	Reduction of Toxicity, Mobility, or Volume	Effective over the Short-Term	Implementable?	Cost?	Acceptable to the State?	Acceptable to the Community?
1	No Further Action	Yes	No	Yes	Yes	Yes	Yes	Low	TBD	TBD
2	MNA with No Further Action for Source Zone	Yes	Yes	Yes	Yes	Yes	Yes	Low	TBD	TBD
3	MNA with Continued Source Removal	Yes	Yes	Yes	Yes	Yes	Yes	High	TBD	TBD
4	In-Situ Solidification/ tabilization	Yes	Yes	Yes	Yes	Yes	Yes	High	TBD	TBD

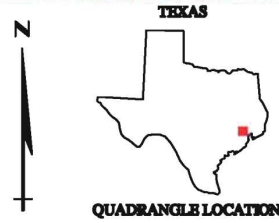
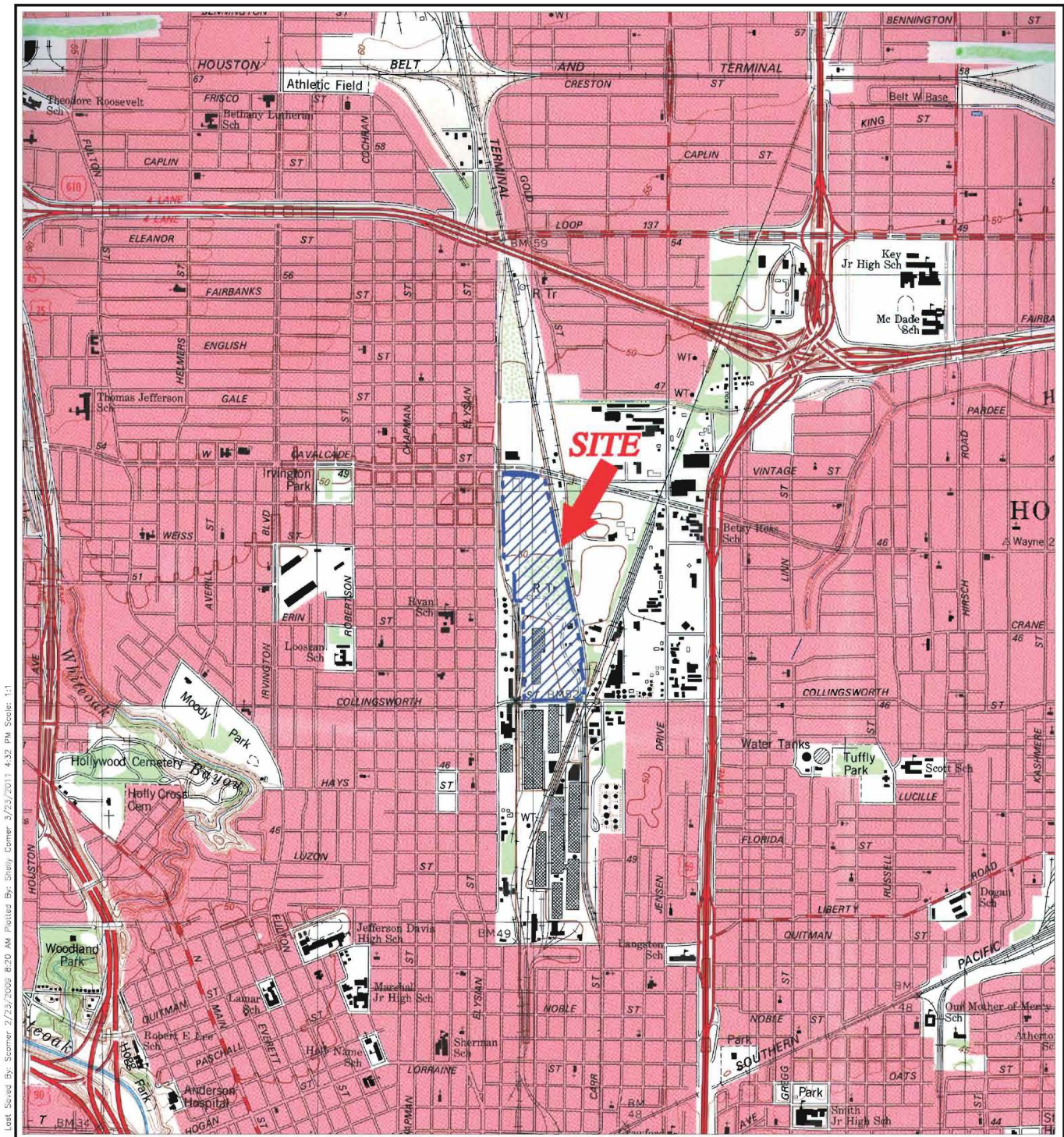
TBD - To Be Determined - Can not be assessed at this time.

TABLE 3-1  
EFFECTIVE SOLUBILITY AND ORGANIC CARBON PARTITIONING COEFFICIENTS  
TECHNICAL IMPRACTICABILITY DEMONSTRATION  
SOUTH CAVALCADE SUPERFUND SITE  
HOUSTON, TEXAS  
BEAZER EAST, INC.

Compound	Effective Solubility (ug/l) <sup>1</sup>	K <sub>oc</sub> <sup>2</sup>
Acenaphthene	1785	5.01 x 10 <sup>3</sup>
Anthracene	339	1.26 x 10 <sup>4</sup>
Benzene	3799	6.46 x 10 <sup>1</sup>
Benzo(a)anthracene	3	1.38 x 10 <sup>6</sup>
Benzo(a)pyrene	0.08	5.50 x 10 <sup>6</sup>
Benzo(g,h,i)perylene	0.05	1.58 x 10 <sup>6</sup>
Chrysene	1	2.00 x 10 <sup>5</sup>
Ethylbenzene	292	6.76 x 10 <sup>2</sup>
Fluoranthene	93	3.80 x 10 <sup>4</sup>
Fluorene	881	7.94 x 10 <sup>3</sup>
Naphthalene	12730	1.29 x 10 <sup>3</sup>
Phenanthrene	598	1.26 x 10 <sup>4</sup>
Pyrene	109	3.80 x 10 <sup>4</sup>
Toluene	1041	2.57 x 10 <sup>2</sup>
Xylenes	313	6.92 x 10 <sup>2</sup>

- 1) Effective Solubility      Feenstra S. and J. A. Cherry, 1990  
Groundwater Contamination by Creosote  
In *Proceedings from the Eleventh Annual Meeting of the  
Canadian Wood Preserving Association*,  
Toronto, Canada
- 2) Organic Carbon      U. S. EPA, 1990, *Subsurface Remediation Guidance*,  
Partition Coefficient (K<sub>oc</sub>)      EPA/540/2-90/011b.

## FIGURES



REFERENCE: USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE  
OF SETTEGAST, TEXAS - 1982

ISSUE DATE:  
  
KEY ENVIRONMENTAL, INC.  
200 THIRD AVENUE  
CARNEGIE, PA 15106

BEAZER EAST, INC  
PITTSBURGH, PENNSYLVANIA

DRWN: SCC	DATE: 07/29/08
CHKD: RMB	DATE: 07/29/08
APPD: JSZ	DATE: 07/29/08
SCALE: 1" = 2000'	



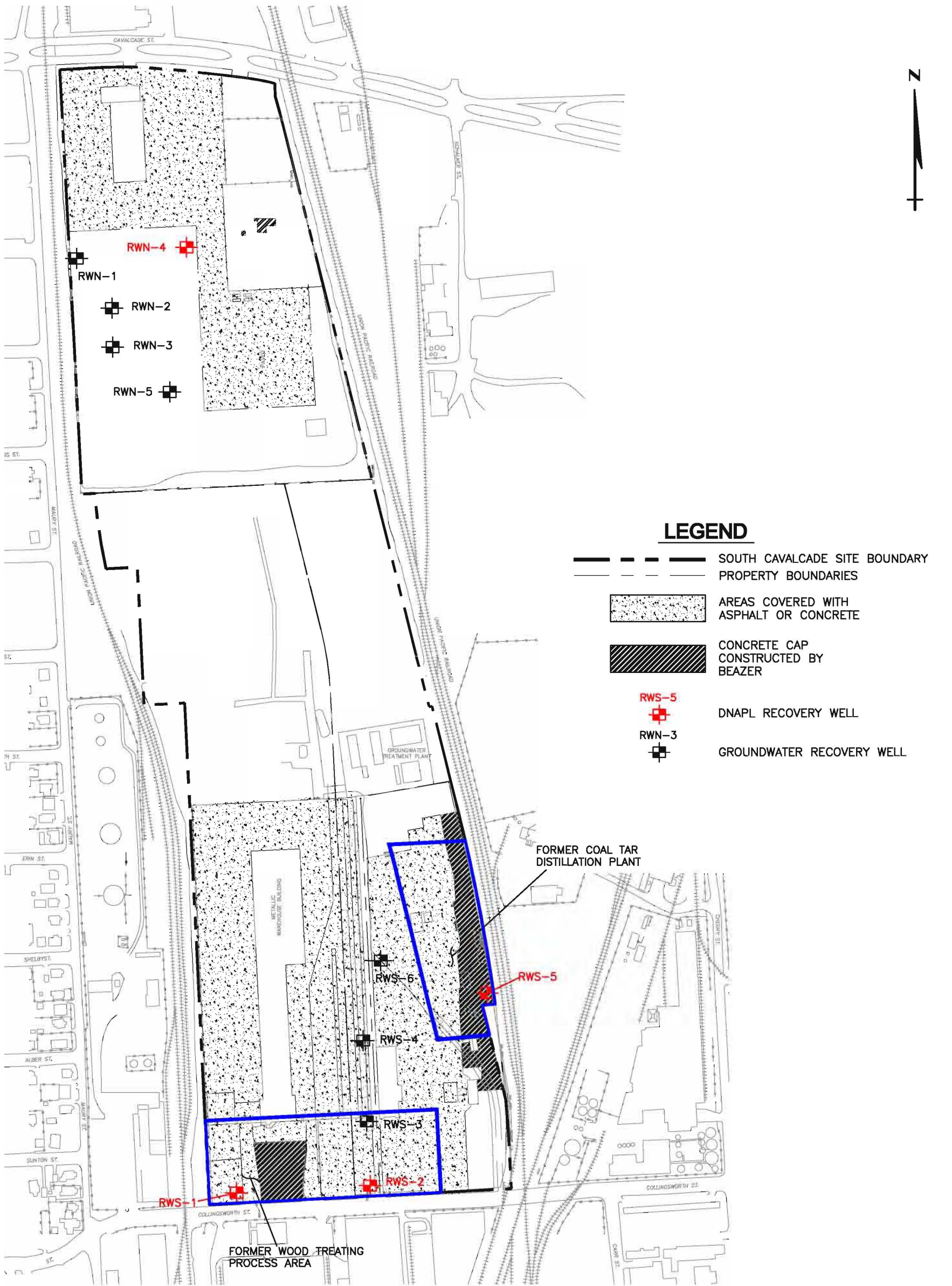
TECHNICAL IMPRACTICABILITY DEMONSTRATION  
SOUTH CAVALCADE SUPERFUND SITE  
HOUSTON, TEXAS

SITE LOCATION MAP

PROJECT NO: 08-683  
FIGURE 1-1

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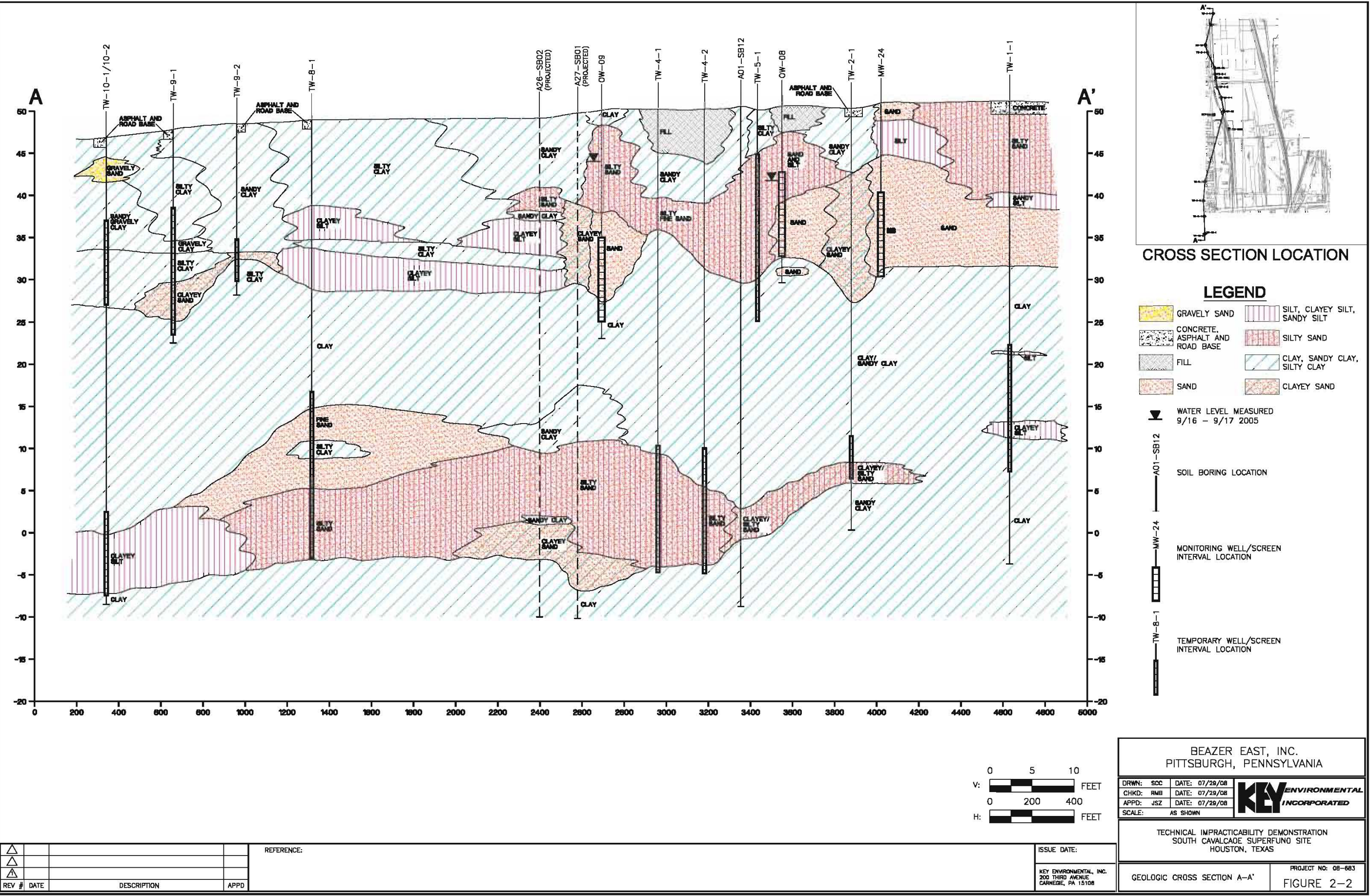


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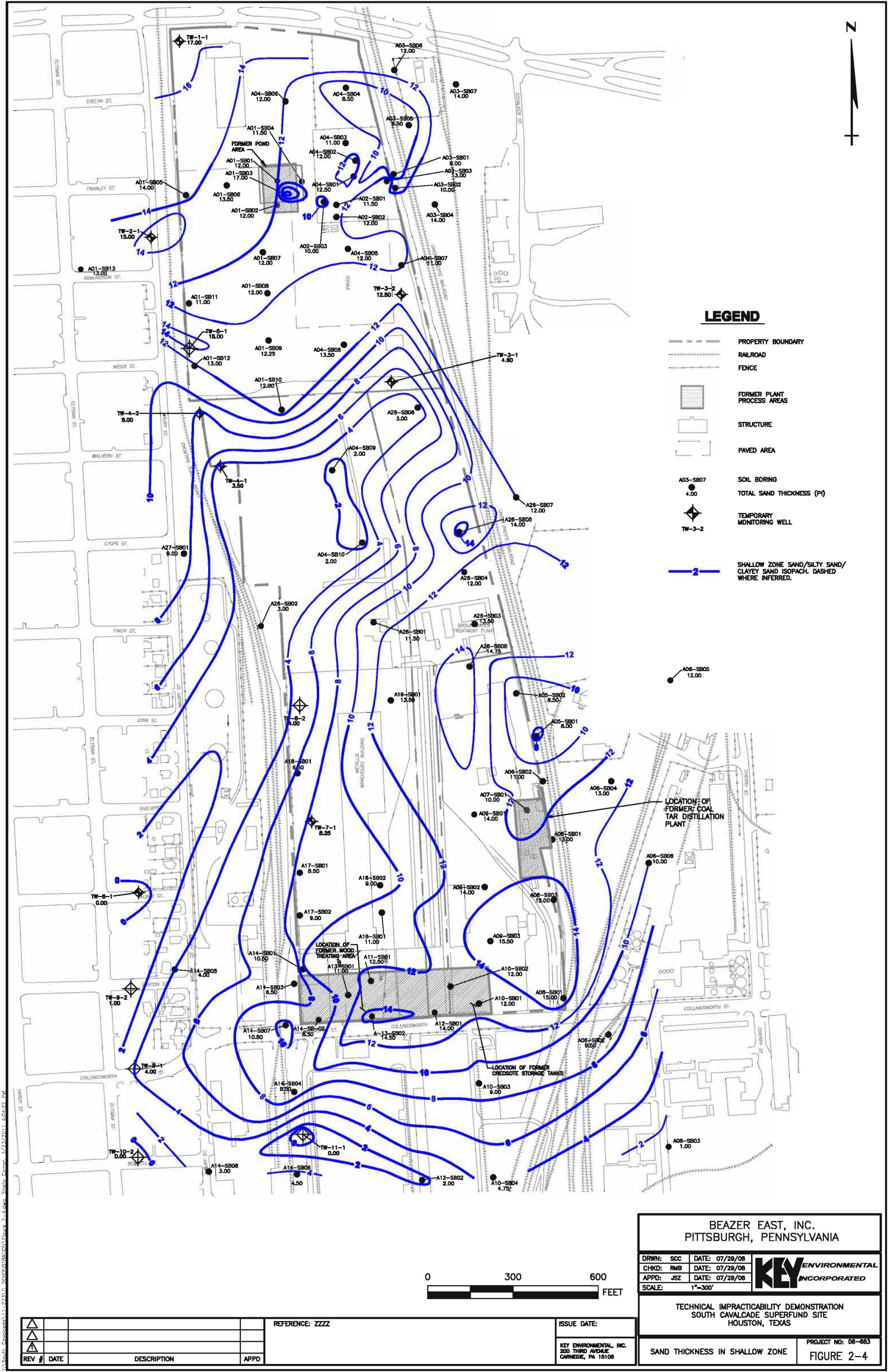
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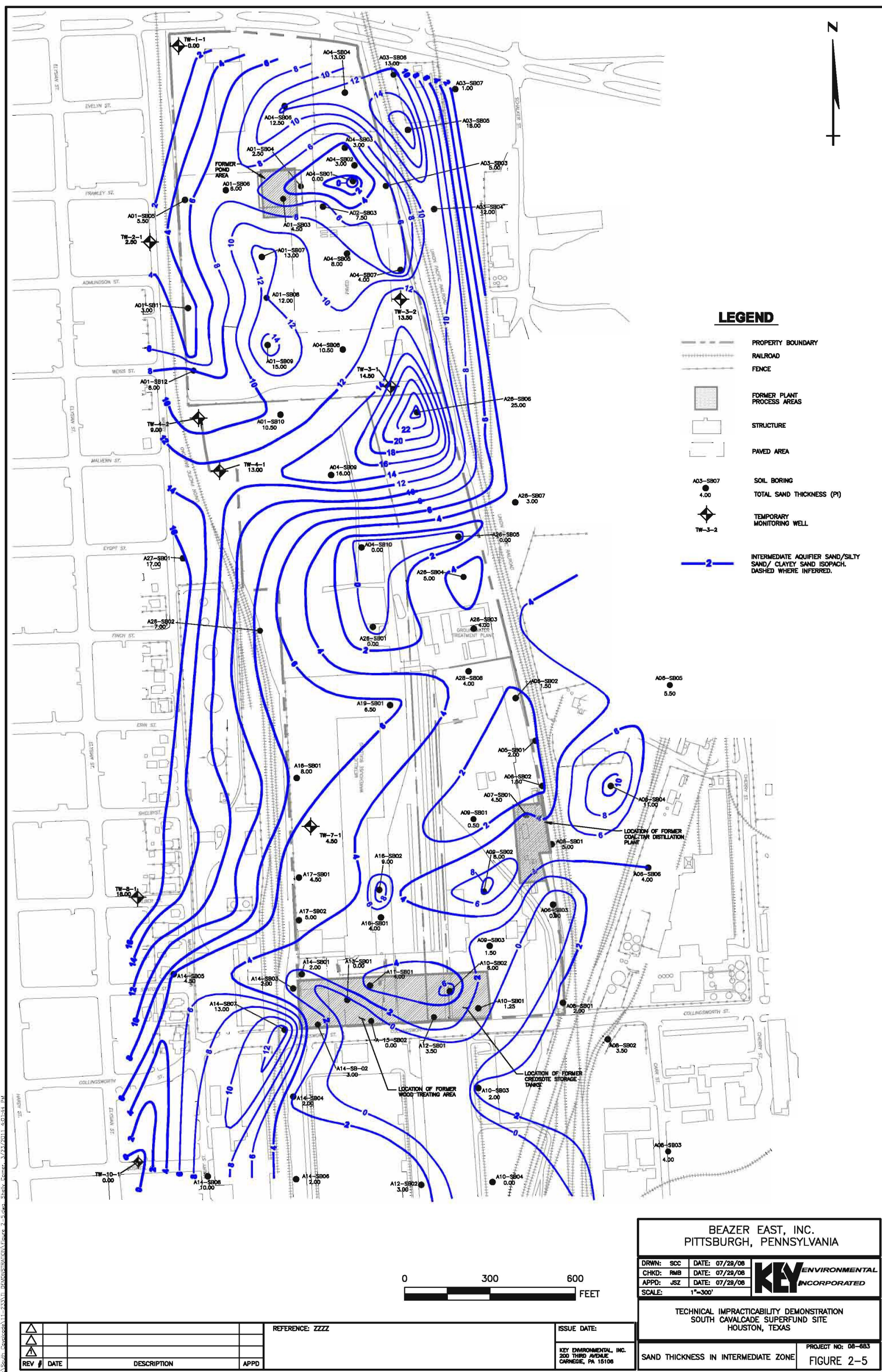
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TECHNICAL IMPRACTICABILITY DEMONSTRATION SOUTH CAVALCADE SUPERFUND SITE HOUSTON, TEXAS	
GENERAL SITE ARRANGEMENT	PROJECT NO: 08-883 FIGURE 2-1

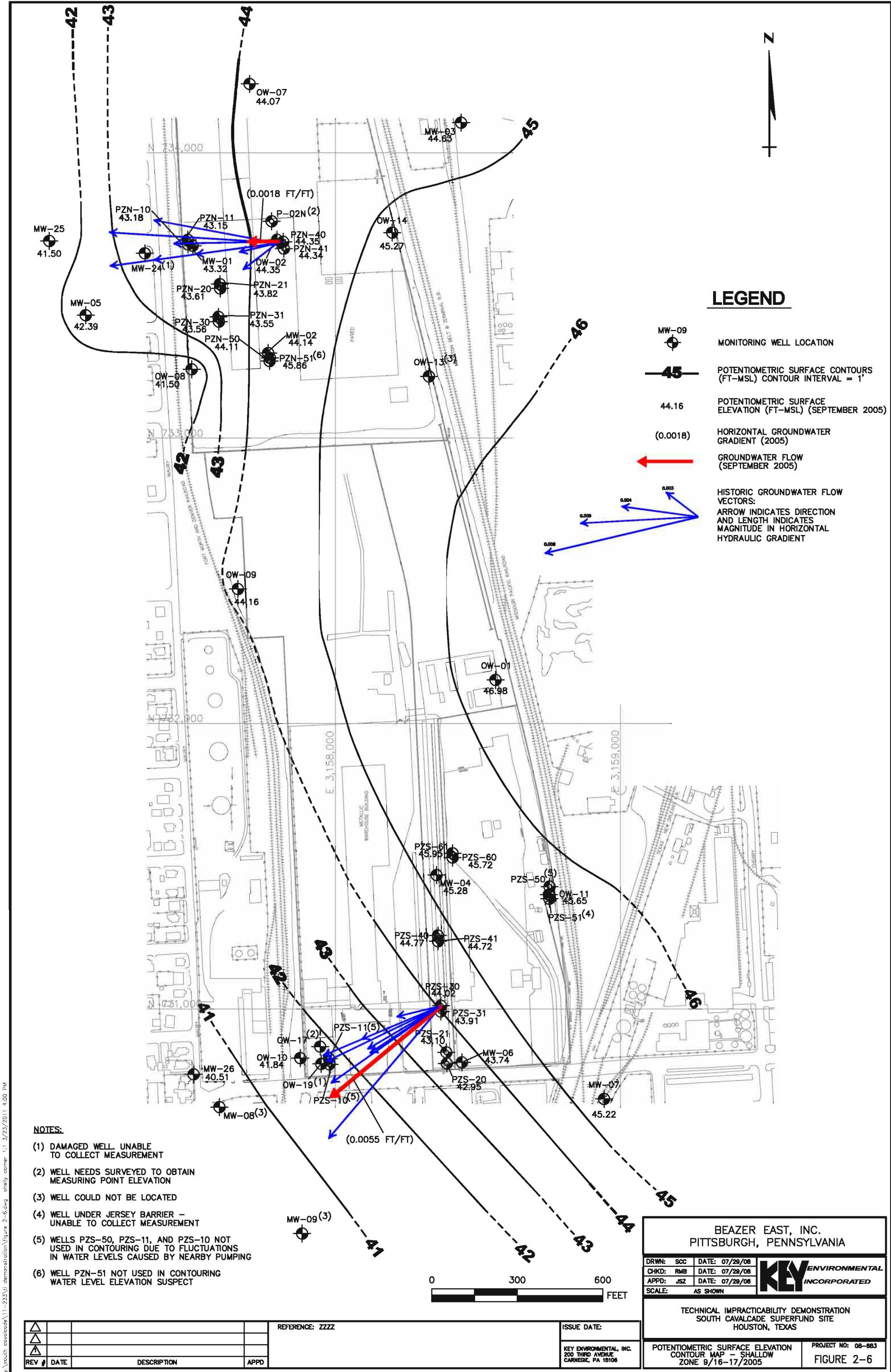
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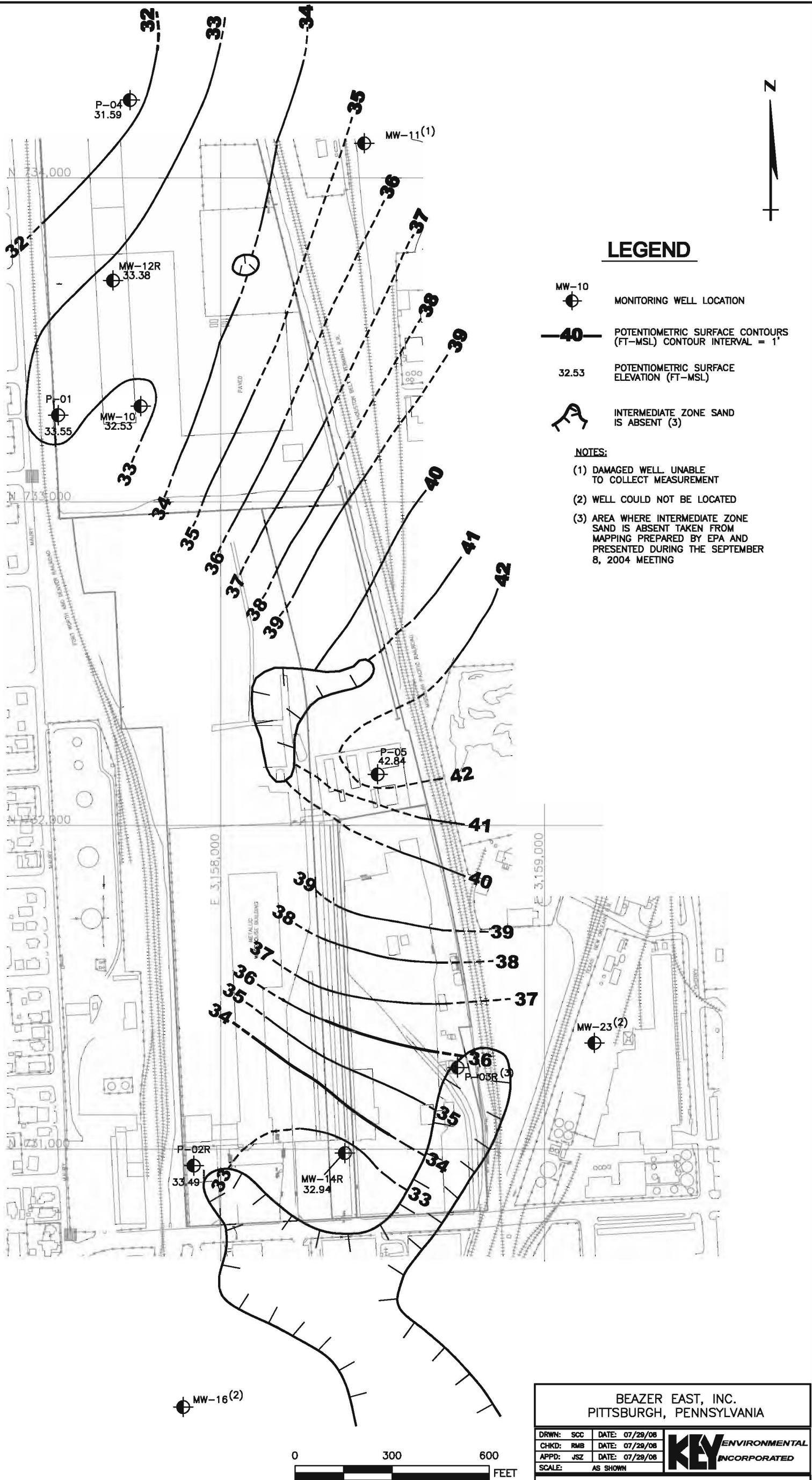








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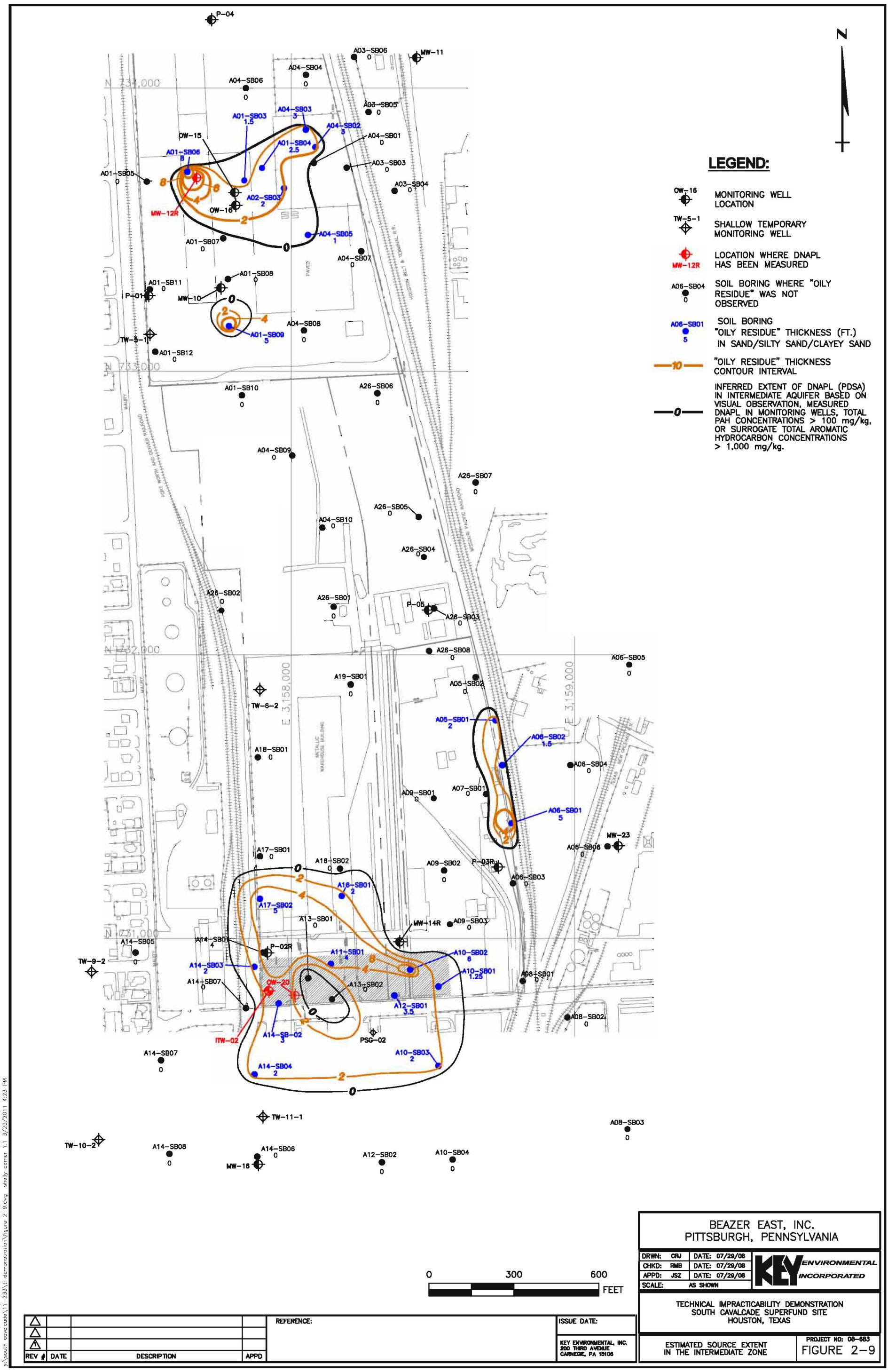


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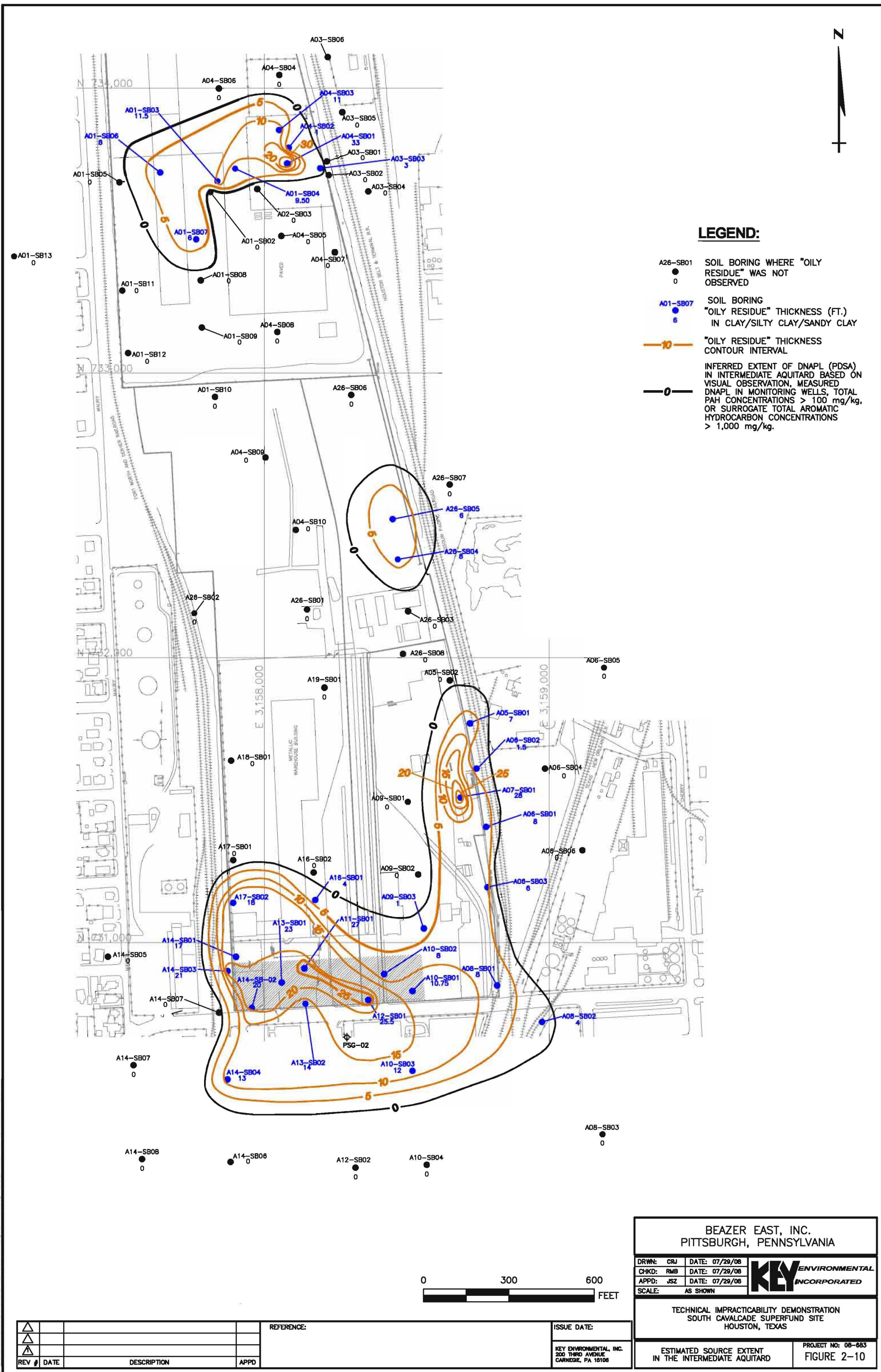
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KEY ENVIRONMENTAL INCORPORATED	
TECHNICAL IMPRACTICABILITY DEMONSTRATION SOUTH CAVALCADE SUPERFUND SITE HOUSTON, TEXAS	
POTENTIOMETRIC SURFACE ELEVATION CONTOUR MAP - INTERMEDIATE ZONE 9/16-17/2005	PROJECT NO: 08-583 FIGURE 2-7

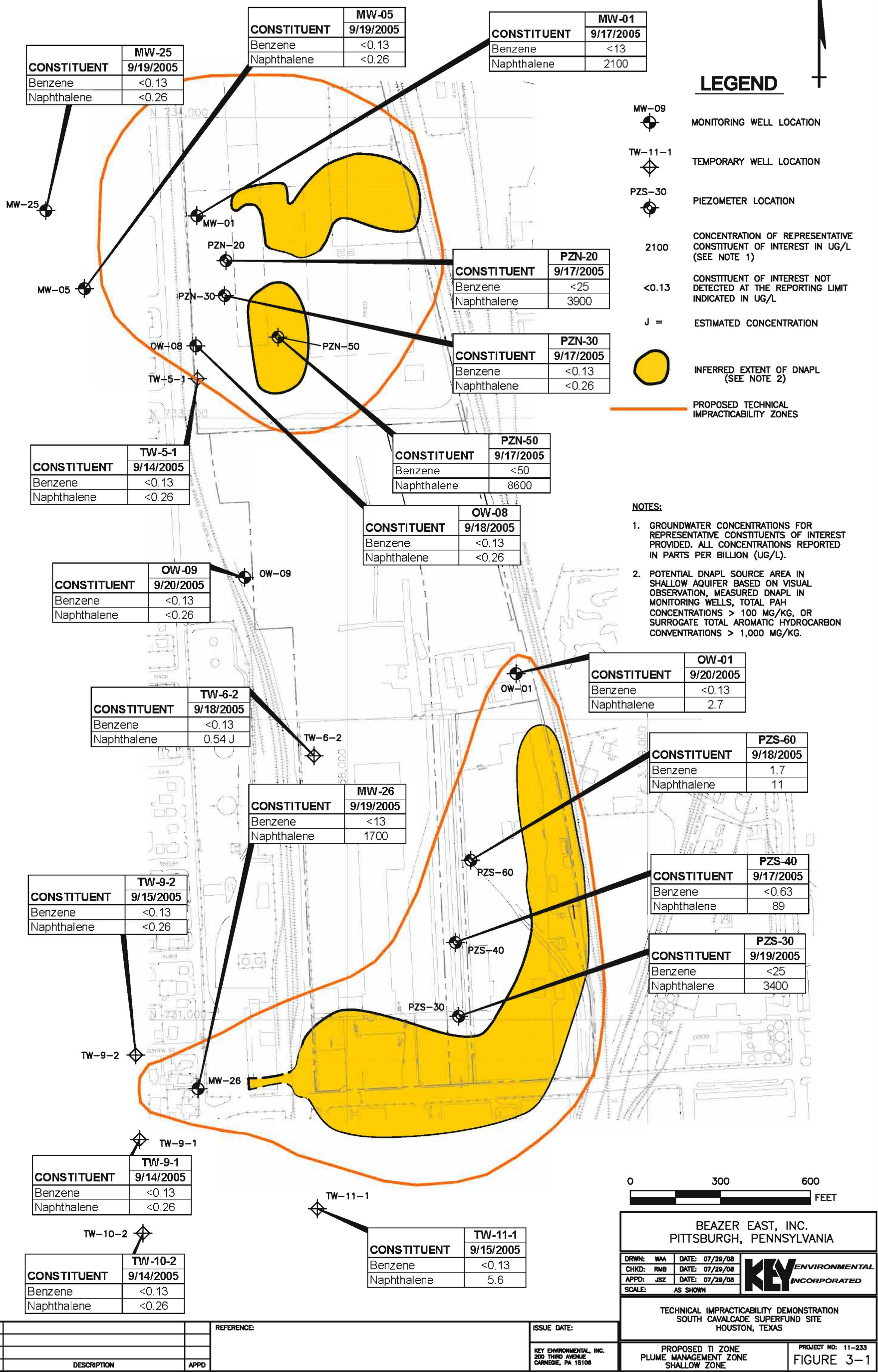


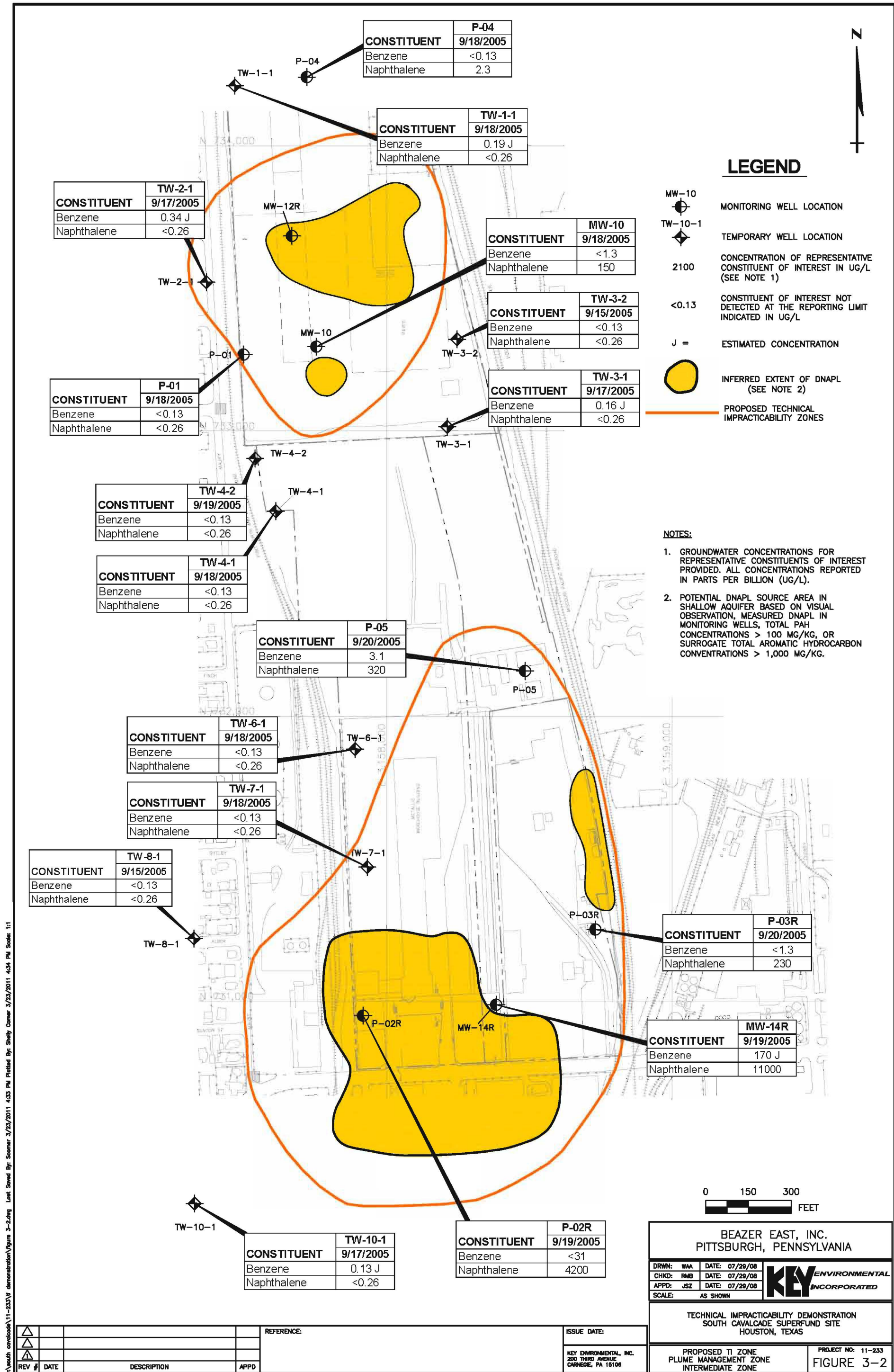


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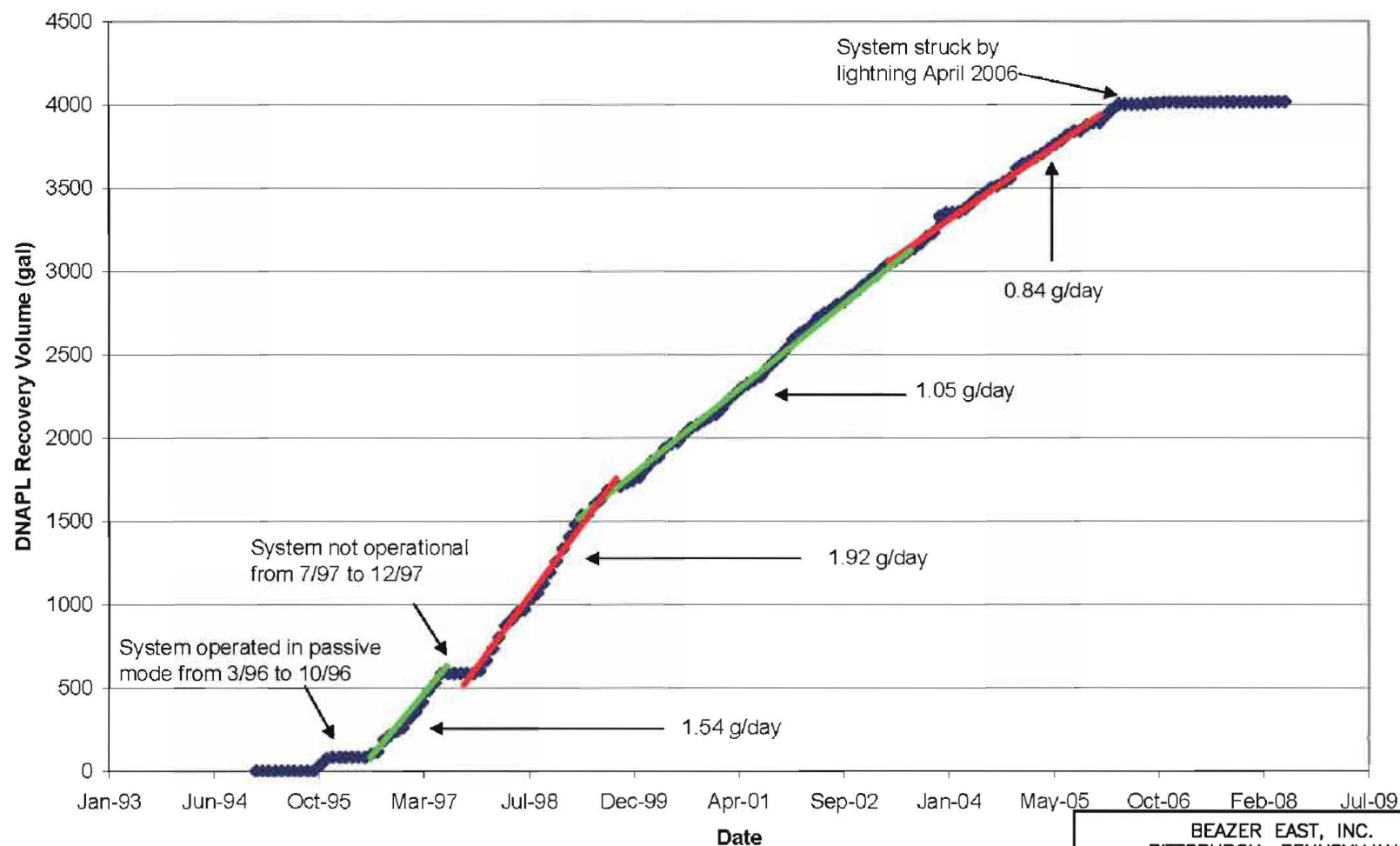


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# Cumulative Site DNAPL Recovery



BEAZER EAST, INC. PITTSBURGH, PENNSYLVANIA			
DRWN: SOC	DATE: 07/29/08	<b>KEY</b> ENVIRONMENTAL INCORPORATED	
CHKD: RMB	DATE: 07/29/08		
APPD: JSZ	DATE: 07/29/08		
SCALE: AS SHOWN			
TECHNICAL IMPRACTICABILITY DEMONSTRATION SOUTH CAVALCADE SUPERFUND SITE HOUSTON, TEXAS			
CUMULATIVE DNAPL RECOVERY			PROJECT NO: 08-883 FIGURE 3-3

REFERENCE:

ISSUE DATE:

KEY ENVIRONMENTAL, INC.  
200 THIRD AVENUE  
CARBONATE, PA 15108

**APPENDIX A**  
**COMPILATION OF ARARS**

## **APPENDIX A**

- RECORD OF DECISION, GROUNDWATER REMEDIAL GOALS, SOUTH CAVALCADE SUPERFUND SITE, U.S. EPA REGION VI
- PROTECTIVE CONCENTRATION LEVELS (PCLs) FOR GROUNDWATER, TABLE 8, TEXAS RISK REDUCTION PROGRAM RULE (30 TAC 350)
- NATIONAL PRIMARY AND SECONDARY DRINKING WATER STANDARDS AND MAXIMUM CONTAMINANT LEVEL GOALS

RECORD OF DECISION – GROUNDWATER REMEDIAL GOALS

SOUTH CAVALCADE SUPERFUND SITE

U.S. EPA REGION VI

taken. These risks are reported in the FS report and are summarized below as the aggregate risk to each receptor group from all site contaminants and pathways. These risks are upper bound estimates of potential effects on human health based on data collected during the Remedial Investigation; the true risks are most likely lower but could be higher if contaminant concentrations in some areas are higher than those sampled during the Remedial Investigation.

<u>Receptor Group</u>	<u>Maximum Noncarcinogenic Hazard Index</u>	<u>Maximum Excess Lifetime Risk of Cancer</u>
On-site Commercial Occupants	<0.01	$4 \times 10^{-7}$
Utility Workers	<0.01	$2 \times 10^{-7}$
Construction Workers	<0.01	$4 \times 10^{-6}$
Trespassing Children	<0.01	$1 \times 10^{-6}$
Potential Future Residents	<0.01	$1 \times 10^{-5}$
Groundwater Users	5.6	$6 \times 10^{-2}$

#### 4.3 REMEDIAL GOALS

EPA concluded from the risk assessment that potential public health hazards exceeded EPA's maximum level for leaving contamination at a site. Using the exposure scenario which considers continued commercial use of the site, target remedial levels for selected chemicals were developed:

<u>Environmental Medium</u>	<u>Contaminant</u>	<u>Remedial Level</u>
Surface and Surficial Soils	Carcinogenic PAHs	700 ppm and no leaching potential
Groundwater	Carcinogenic PAHs	no detection
Groundwater	Benzene	5 ug/l
Groundwater	Ethylbenzene	142 ug/l
Groundwater	Toluene	28 ug/l
Groundwater	Xylene	440 ug/l
Groundwater	Arsenic	50 ug/l
Groundwater	Chromium	50 ug/l
Groundwater	Copper	28 ug/l
Groundwater	Lead	50 ug/l
Groundwater	Zinc	100 ug/l

The remedial level for soils was selected to prevent against an additional risk of cancer from exposure to soils of greater than 1 in 100,000 ( $10^{-5}$ ) for on-site commercial occupants and also

ensure against any non-carcinogenic hazards. The  $10^{-5}$  cancer risk level was selected as appropriate for a commercial site where only a few people may ever become exposed. In addition, the cancer potency for carcinogenic PAHs may be overstated in the risk assessment. The actual potencies can be lower by 10 to 100 times; this would reduce the estimated cancer risk by 10 times at a minimum. The remedial level will also assure that contaminants will not continue to leach into the groundwater.

The remedial levels for groundwater were ~~selected to comply with~~ Federal drinking water standards, NPDES BAT requirements, and Texas water Quality standards which are relevant and appropriate requirements (see Appendix B for the list of ARARs) or reflect existing background groundwater concentration levels. The remedial level for carcinogenic PAHs was selected to assure that, in conjunction with other contaminants, the overall risk to potential consumers of groundwater will be less than  $10^{-4}$ . A higher risk level was used for groundwater because the aquifers to be remediated are not being used as water supplies, nor are likely to be used because there are available water sources in the area. The actual risk will be lower as natural adsorption reduces the concentration of PAHs and metals. Levels were developed for copper and zinc based on the principle of keeping the hazard index less than 1.

From the Remedial Investigation results, approximately 3 acres of soil above 6 feet in depth and 50 million gallons of groundwater exceed these levels. Figures 4 and 5 show the areas of surficial soil and groundwater where remediation may be needed.

##### 5. COMMUNITY RELATIONS HISTORY

Community concern of either area residents or local officials is very low at the site. The site is used by three trucking firms and is in a light industrial area. Therefore, citizen awareness and concern about the site is limited.

EPA held the first community meeting on September 11, 1985, to discuss the reasons for listing the site on the NPL and to present the schedule for the site investigation. Fact sheets were periodically mailed to local residents and interested parties to describe the field activities.

On August 12, 1988, EPA issued a press release and the Proposed Plan fact sheet. The press release was mailed to all news organizations in the Houston area; the fact sheet was mailed to 75 residents, the three on-site trucking firms, and local officials. Extra copies of the fact sheet were provided to the five local repositories for display.

In accordance with Section 117 of CERCLA, both the press release and fact sheet announced the comment period which began on August 22 and ended on September 19, 1988. A public meeting was held on August 29, 1988, at the Ryan Civic Center. Approximately 39

PROTECTIVE CONCENTRATION LEVELS (PCLs) FOR GROUNDWATER

TEXAS RISK REDUCTION PROGRAM RULE (30 TAC 350)

**Table 8**  
**Individual Tier 1 Groundwater PCLs**  
**Residential and Commercial/Industrial**

	Residential						Commercial/Industrial					
	Carcinogenic		Noncarcinogenic				Carcinogenic		Noncarcinogenic			
Chemical of Concern					Air GW <sub>Inh-V</sub> 0.5 acre source area	Air GW <sub>Inh-V</sub> 30 acre source area					Air GW <sub>Inh-V</sub> 0.5 acre source area	Air GW <sub>Inh-V</sub> 30 acre source area
	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	(mg/L)	(mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	(mg/L)	(mg/L)
Acenaphthene			1.5E+00	1.5E+02					4.4E+00	4.4E+02		
Acenaphthylene			1.5E+00	1.5E+02					4.4E+00	4.4E+02		
Acetaldehyde			2.4E+00	2.4E+02	2.4E+03	3.1E+02			7.3E+00	7.3E+02	3.3E+03	4.3E+02
Acetate, 2-ethoxyethanol			4.2E-01	4.2E+01	2.0E+05	2.6E+04			1.2E+00	1.2E+02	2.8E+05	3.7E+04
Acetate, isoamyl			1.8E+00	1.8E+02	2.9E+04	3.8E+03			5.3E+00	5.3E+02	4.1E+04	5.3E+03
Acetate, isobutyl			1.2E+00	1.2E+02	4.9E+04	6.3E+03			3.5E+00	3.5E+02	6.8E+04	8.8E+03
Acetate, sec-butyl			1.2E+00	1.2E+02	7.3E+04	9.4E+03			3.5E+00	3.5E+02	1.0E+05	1.3E+04
Acetic acid*												
Acetone (2-propanone)			2.2E+01	2.2E+03	2.5E+05	3.3E+04			6.6E+01	6.6E+03	3.5E+05	4.6E+04
Acetone cyanohydrin			7.3E-02	7.3E+00	3.4E+05	4.4E+04			2.2E-01	2.2E+01	4.8E+05	6.2E+04
Acetonitrile			7.8E-01	7.8E+01	3.2E+04	4.2E+03			2.3E+00	2.3E+02	4.5E+04	5.8E+03
Acetophenone			2.4E+00	2.4E+02	1.4E+05	1.8E+04			7.3E+00	7.3E+02	1.9E+05	2.5E+04
Acetylaminofluorene, 2-	2.4E-04	2.4E-02			6.3E+02	1.0E+02	5.4E-04	5.4E-02			1.1E+03	1.8E+02
Acifluorfen, sodium			3.2E-01	3.2E+01	1.3E+07	1.3E+07			9.5E-01	9.5E+01	1.8E+07	1.8E+07
Acridine			7.3E-02	7.3E+00					2.2E-01	2.2E+01		
Acrolein			1.2E-02	1.2E+00	7.0E+01	9.1E+00			3.7E-02	3.7E+00	9.8E+01	1.3E+01
Acrylamide	1.8E-03	1.8E-01	4.9E-02	4.9E+00	3.8E+03	5.0E+02	4.1E-03	4.1E-01	1.5E-01	1.5E+01	6.3E+03	8.4E+02
Acrylic acid			1.2E+01	1.2E+03	1.5E+04	2.0E+03			3.7E+01	3.7E+03	2.1E+04	2.7E+03
Acrylonitrile	1.7E-03	1.7E-01	2.4E-02	2.4E+00	5.8E+01	7.5E+00	3.8E-03	3.8E-01	7.3E-02	7.3E+00	9.7E+01	1.3E+01
Adipic acid (hexanedioic acid)			4.9E+01	4.9E+03	4.2E+05	3.1E+05			1.5E+02	1.5E+04	5.9E+05	4.3E+05
Alachlor												
Aldicarb												
Aldicarb sulfone												
Aldrin	5.4E-05	5.4E-03	7.3E-04	7.3E-02	4.4E+00	5.7E-01	1.2E-04	1.2E-02	2.2E-03	2.2E-01	7.4E+00	9.6E-01
Allyl alcohol			1.2E-01	1.2E+01	8.9E+02	1.1E+02			3.7E-01	3.7E+01	1.2E+03	1.6E+02
Allyl chloride			2.4E-01	2.4E+01	9.1E+00	1.2E+00			7.3E-01	7.3E+01	1.3E+01	1.7E+00
Aluminum			2.4E+01	2.4E+03					7.3E+01	7.3E+03		
Ametryn			2.2E-01	2.2E+01					6.6E-01	6.6E+01		
Amino-2,6-dinitrotoluene, 4-	9.1E-02	9.1E+00	4.1E-03	4.1E-01	2.8E+03	3.6E+02	2.0E-01	2.0E+01	1.2E-02	1.2E+00	3.9E+03	5.1E+02
Amino-4,6-dinitrotoluene, 2-	9.1E-02	9.1E+00	4.1E-03	4.1E-01	2.8E+03	3.6E+02	2.0E-01	2.0E+01	1.2E-02	1.2E+00	3.9E+03	5.1E+02
Aminobiphenyl, 4- (1,1-biphenyl-4-amine)	1.5E-04	1.5E-02					3.4E-04	3.4E-02				
Aminopyridine, 4-			4.9E-04	4.9E-02	4.7E+03	6.1E+02			1.5E-03	1.5E-01	6.6E+03	8.5E+02
Ammonia					2.7E+03	3.5E+02					3.8E+03	4.9E+02
Ammonium polyphosphate*												

**Table 8**  
**Individual Tier 1 Groundwater PCLs**  
**Residential and Commercial/Industrial**

	Residential						Commercial/Industrial					
	Carcinogenic		Noncarcinogenic				Carcinogenic		Noncarcinogenic			
Chemical of Concern					Air GW <sub>Inh-V</sub> 0.5 acre source area	Air GW <sub>Inh-V</sub> 30 acre source area					Air GW <sub>Inh-V</sub> 0.5 acre source area	Air GW <sub>Inh-V</sub> 30 acre source area
	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	(mg/L)	(mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	(mg/L)	(mg/L)
Ammonium salts*												
Aniline	1.6E-01	1.6E+01	1.7E-01	1.7E+01	1.1E+04	1.4E+03	3.6E-01	3.6E+01	5.1E-01	5.1E+01	1.6E+04	2.0E+03
Anthracene			7.3E+00	7.3E+02					2.2E+01	2.2E+03		
Anthraquinone, 9,10-			4.9E-01	4.9E+01					1.5E+00	1.5E+02		
Antimony												
Aramite	3.7E-02	3.7E+00	1.2E+00	1.2E+02			8.2E-02	8.2E+00	3.7E+00	3.7E+02		
Arsenic												
Arsine												
Asbestos												
Atrazine					1.8E+05	2.4E+04					2.6E+05	3.3E+04
Azinphos-methyl (guthion)			3.7E-02	3.7E+00					1.1E-01	1.1E+01		
Azobenzene	8.3E-03	8.3E-01			6.8E+02	8.8E+01	1.9E-02	1.9E+00			1.1E+03	1.5E+02
Barium												
Bayleton			7.3E-01	7.3E+01					2.2E+00	2.2E+02		
Benefin (benfluralin)			7.3E+00	7.3E+02					2.2E+01	2.2E+03		
Benomyl			1.2E+00	1.2E+02					3.7E+00	3.7E+02		
Benz-a-anthracene	1.3E-03	1.3E-01			2.0E+03	2.6E+02	2.8E-03	2.8E-01			3.4E+03	4.4E+02
Benzaldehyde			2.4E+00	2.4E+02	5.2E+03	6.7E+02			7.3E+00	7.3E+02	7.3E+03	9.4E+02
Benzene					1.8E+02	2.3E+01					3.0E+02	3.9E+01
Benzenediacarbonitrile, 1,3-			1.5E-01	1.5E+01					4.4E-01	4.4E+01		
Benzenedicarboxylic acid, 1,2-disodecyl ester			9.8E-01	9.8E+01	1.5E+05	1.9E+04			2.9E+00	2.9E+02	2.0E+05	2.6E+04
Benzenethiol			2.4E-04	2.4E-02	4.5E+01	5.8E+00			7.3E-04	7.3E-02	6.3E+01	8.2E+00
Benzidine	4.0E-06	4.0E-04	7.3E-02	7.3E+00	5.0E+00	8.4E-01	8.9E-06	8.9E-04	2.2E-01	2.2E+01	8.4E+00	1.4E+00
Benzo-a-pyrene					3.9E+02	5.0E+01					6.5E+02	8.4E+01
Benzo-b-fluoranthene	1.3E-03	1.3E-01			1.6E+03	2.1E+02	2.8E-03	2.8E-01			2.7E+03	3.5E+02
Benzo-e-pyrene			7.3E-01	7.3E+01					2.2E+00	2.2E+02		
Benzo-g,h,i-perylene			7.3E-01	7.3E+01					2.2E+00	2.2E+02		
Benzoic acid			9.8E+01	9.8E+03	1.0E+05	1.3E+04			2.9E+02	2.9E+04	1.5E+05	1.9E+04
Benzo-j-fluoranthene	1.3E-03	1.3E-01			1.0E+03	1.3E+02	2.8E-03	2.8E-01			1.7E+03	2.3E+02
Benzo-k-fluoranthene	1.3E-02	1.3E+00			9.7E+04	1.3E+04	2.8E-02	2.8E+00			1.6E+05	2.1E+04
Benzophenone			1.6E-01	1.6E+01					4.9E-01	4.9E+01		
Benzotrachloride	7.0E-05	7.0E-03			8.5E+01	1.1E+01	1.6E-04	1.6E-02			1.2E+02	1.5E+01
Benzoyl peroxide			1.2E+00	1.2E+02	1.6E+05	2.1E+04			3.7E+00	3.7E+02	2.2E+05	2.9E+04
Benzyl alcohol			2.4E+00	2.4E+02	9.1E+05	1.2E+05			7.3E+00	7.3E+02	1.3E+06	1.7E+05

**Table 8**  
**Individual Tier 1 Groundwater PCLs**  
**Residential and Commercial/Industrial**

	Residential						Commercial/Industrial					
	Carcinogenic		Noncarcinogenic				Carcinogenic		Noncarcinogenic			
Chemical of Concern					Air GW <sub>Inh-V</sub> 0.5 acre source area	Air GW <sub>Inh-V</sub> 30 acre source area					Air GW <sub>Inh-V</sub> 0.5 acre source area	Air GW <sub>Inh-V</sub> 30 acre source area
	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)			GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)		
Benzyl chloride	5.4E-03	5.4E-01	4.9E-02	4.9E+00	1.0E+02	1.3E+01	1.2E-02	1.2E+00	1.5E-01	1.5E+01	1.4E+02	1.8E+01
Benzyl dichloride	5.4E-03	5.4E-01			4.0E+02	5.1E+01	1.2E-02	1.2E+00			5.6E+02	7.2E+01
Beryllium												
Biphenyl, 1,1'-			1.2E+00	1.2E+02	2.0E+02	2.6E+01			3.7E+00	3.7E+02	2.8E+02	3.7E+01
Biphenyl, 1,1'-, 2-phenoxy-			1.2E+00	1.2E+02					3.7E+00	3.7E+02		
Biquinoline, 2,2'-			7.3E-02	7.3E+00					2.2E-01	2.2E+01		
Bis (2-chloroethoxy) methane	8.3E-04	8.3E-02	7.3E-02	7.3E+00	8.0E+01	1.0E+01	1.9E-03	1.9E-01	2.2E-01	2.2E+01	1.3E+02	1.7E+01
Bis (2-chloroethyl) ether	8.3E-04	8.3E-02			9.3E+01	1.2E+01	1.9E-03	1.9E-01			1.6E+02	2.0E+01
Bis (2-chloroisopropyl) ether	1.3E-02	1.3E+00	9.8E-01	9.8E+01	8.7E+02	1.1E+02	2.9E-02	2.9E+00	2.9E+00	2.9E+02	1.5E+03	1.9E+02
Bis (2-chloromethyl) ether	4.1E-06	4.1E-04			8.5E-02	1.1E-02	9.3E-06	9.3E-04			1.4E-01	1.9E-02
Bis (2-ethyl-hexyl) phthalate												
Bismuth			1.2E+01	1.2E+03					3.7E+01	3.7E+03		
Bisphenol A			1.2E+00	1.2E+02	3.2E+06	7.4E+05			3.7E+00	3.7E+02	4.4E+06	1.0E+06
Boron			4.9E+00	4.9E+02					1.5E+01	1.5E+03		
Bromacil			2.4E+00	2.4E+02					7.3E+00	7.3E+02		
Bromo-2-chloroethane, 1-			9.8E-01	9.8E+01	2.5E+03	3.3E+02			2.9E+00	2.9E+02	3.6E+03	4.6E+02
Bromobenzene			2.0E-01	2.0E+01	2.3E+03	2.9E+02			5.8E-01	5.8E+01	3.2E+03	4.1E+02
Bromodichloromethane <sup>3</sup>	1.5E-02	1.5E+00	4.9E-01	4.9E+01			3.3E-02	3.3E+00	1.5E+00	1.5E+02		
Bromoform <sup>3</sup>	1.2E-01	1.2E+01	4.9E-01	4.9E+01	5.1E+03	6.7E+02	2.6E-01	2.6E+01	1.5E+00	1.5E+02	8.6E+03	1.1E+03
Bromomethane			3.4E-02	3.4E+00	4.6E+01	6.0E+00			1.0E-01	1.0E+01	6.4E+01	8.3E+00
Bromophenyl phenylether, 4-	6.1E-05	6.1E-03			1.6E+00	2.0E-01	1.4E-04	1.4E-02			2.7E+00	3.4E-01
Butadiene, 1,3-					3.6E+01	4.7E+00					5.1E+01	6.6E+00
Butadiene, 2-methyl-1,3- (isoprene)			1.5E+00	1.5E+02	8.2E+04	1.1E+04			4.4E+00	4.4E+02	1.2E+05	1.5E+04
Butanal (butyraldehyde)			1.5E+00	1.5E+02	1.6E+05	2.1E+04			4.4E+00	4.4E+02	2.2E+05	2.9E+04
Butane, 2,3-dimethyl-			1.5E+00	1.5E+02	2.4E+03	3.0E+02			4.4E+00	4.4E+02	3.3E+03	4.3E+02
Butanoic acid (butyric acid)			1.2E+01	1.2E+03	1.9E+04	2.5E+03			3.7E+01	3.7E+03	2.7E+04	3.4E+03
Butanol, 1-, 2-Me-			2.4E-01	2.4E+01	6.7E+05	8.7E+04			7.3E-01	7.3E+01	9.4E+05	1.2E+05
Butanol, 2-			4.9E+01	4.9E+03	5.2E+07	6.8E+06			1.5E+02	1.5E+04	7.3E+07	9.5E+06
Butanol, 2-methyl-2-			2.4E-01	2.4E+01	6.3E+05	8.1E+04			7.3E-01	7.3E+01	8.8E+05	1.1E+05
Butanol, n-			2.4E+00	2.4E+02	2.0E+05	2.6E+04			7.3E+00	7.3E+02	2.8E+05	3.6E+04
Butene, 1-			1.5E+00	1.5E+02	1.0E+04	1.3E+03			4.4E+00	4.4E+02	1.4E+04	1.8E+03
Butene, cis-2-			1.5E+00	1.5E+02	1.4E+04	1.9E+03			4.4E+00	4.4E+02	2.0E+04	2.6E+03
Butene, trans-2-			1.5E+00	1.5E+02	1.4E+04	1.9E+03			4.4E+00	4.4E+02	2.0E+04	2.6E+03
Butoxy ethanol, 2- (Ethylene glycol monobutyl ether; EGBE)			1.2E+01	1.2E+03	2.3E+08	3.0E+07			3.7E+01	3.7E+03	3.2E+08	4.1E+07

**Table 8**  
**Individual Tier 1 Groundwater PCLs**  
**Residential and Commercial/Industrial**

	Residential						Commercial/Industrial					
	Carcinogenic		Noncarcinogenic				Carcinogenic		Noncarcinogenic			
Chemical of Concern					Air GW <sub>Inh-V</sub> 0.5 acre source area (mg/L)	Air GW <sub>Inh-V</sub> 30 acre source area (mg/L)					Air GW <sub>Inh-V</sub> 0.5 acre source area (mg/L)	Air GW <sub>Inh-V</sub> 30 acre source area (mg/L)
	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)			GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)		
Butyl acetate			3.4E+00	3.4E+02	1.0E+04	1.3E+03			1.0E+01	1.0E+03	1.5E+04	1.9E+03
Butyl acrylate			2.2E-01	2.2E+01	7.9E+02	1.0E+02			6.6E-01	6.6E+01	1.1E+03	1.4E+02
Butyl benzyl phthalate	4.8E-01	4.8E+01	4.9E+00	4.9E+02	1.2E+05	1.6E+04	1.1E+00	1.1E+02	1.5E+01	1.5E+03	1.7E+05	2.2E+04
Butyl ether, n- (dibutyl ether)			2.4E+00	2.4E+02	5.0E+03	6.5E+02			7.3E+00	7.3E+02	7.0E+03	9.1E+02
Butyl methacrylate			2.2E+00	2.2E+02	8.1E+04	1.0E+04			6.6E+00	6.6E+02	1.1E+05	1.5E+04
Butylate			1.2E+00	1.2E+02					3.7E+00	3.7E+02		
Butylbenzene, n-			9.8E-01	9.8E+01	3.6E+03	4.7E+02			2.9E+00	2.9E+02	5.1E+03	6.6E+02
Butylbenzene, sec-			9.8E-01	9.8E+01	3.9E+03	5.0E+02			2.9E+00	2.9E+02	5.4E+03	7.0E+02
Butylbenzene, tert-			9.8E-01	9.8E+01	2.5E+03	3.2E+02			2.9E+00	2.9E+02	3.5E+03	4.5E+02
Cacodylic acid			7.3E-02	7.3E+00					2.2E-01	2.2E+01		
Cadmium												
Calcium*												
Caprolactam			1.2E+01	1.2E+03	2.4E+04	3.2E+03			3.7E+01	3.7E+03	3.4E+04	4.4E+03
Captan	2.6E-01	2.6E+01	3.2E+00	3.2E+02	5.6E+04	7.2E+03	5.8E-01	5.8E+01	9.5E+00	9.5E+02	7.8E+04	1.0E+04
Carbaryl			2.4E+00	2.4E+02	1.8E+05	2.3E+04			7.3E+00	7.3E+02	2.5E+05	3.3E+04
Carbazole	4.6E-02	4.6E+00					1.0E-01	1.0E+01				
Carbofuran					3.8E+03	4.9E+02					5.3E+03	6.8E+02
Carbon disulfide			2.4E+00	2.4E+02	4.9E+03	6.3E+02			7.3E+00	7.3E+02	6.8E+03	8.8E+02
Carbon tetrachloride					7.9E+00	1.0E+00					1.3E+01	1.7E+00
Carbophenothion			3.2E-01	3.2E+01					9.5E-01	9.5E+01		
Carbosulfan			2.4E-01	2.4E+01					7.3E-01	7.3E+01		
Carboxin			2.4E+00	2.4E+02					7.3E+00	7.3E+02		
Chloral			2.4E+00	2.4E+02	8.4E+04	1.1E+04			7.3E+00	7.3E+02	1.2E+05	1.5E+04
Chloral hydrate (1,1-ethanediol, 2,2,2-trichloro-)			2.4E+00	2.4E+02	1.1E+05	1.5E+04			7.3E+00	7.3E+02	1.6E+05	2.2E+04
Chloramben (amiben; 3-amino-2,5-dichlorobenzoic acid)			3.7E-01	3.7E+01					1.1E+00	1.1E+02		
Chlordane (technical)					7.7E+02	9.9E+01					1.3E+03	1.7E+02
Chlordane, cis- (alpha chlordane)	2.6E-03	2.6E-01	1.2E-02	1.2E+00	1.5E+02	2.0E+01	5.8E-03	5.8E-01	3.7E-02	3.7E+00	2.6E+02	3.3E+01
Chlordane, gamma	2.6E-03	2.6E-01	1.2E-02	1.2E+00	1.5E+02	2.0E+01	5.8E-03	5.8E-01	3.7E-02	3.7E+00	2.6E+02	3.3E+01
Chlorfenvinphos			1.7E-02	1.7E+00					5.1E-02	5.1E+00		
Chloride*												
Chlorine					2.2E+00	2.8E-01					3.1E+00	4.0E-01
Chloro-1,3-butadiene, 2-					2.5E+01	3.3E+00					3.6E+01	4.6E+00
Chloro-2-propanol, 1-			4.9E-01	4.9E+01					1.5E+00	1.5E+02		
Chloro-3-methylphenol, 4-			1.2E-01	1.2E+01	6.0E+05	7.7E+04			3.7E-01	3.7E+01	8.4E+05	1.1E+05

**Table 8**  
**Individual Tier 1 Groundwater PCLs**  
**Residential and Commercial/Industrial**

	Residential						Commercial/Industrial					
	Carcinogenic		Noncarcinogenic				Carcinogenic		Noncarcinogenic			
Chemical of Concern					Air GW <sub>Inh-V</sub> 0.5 acre source area (mg/L)	Air GW <sub>Inh-V</sub> 30 acre source area (mg/L)					Air GW <sub>Inh-V</sub> 0.5 acre source area (mg/L)	Air GW <sub>Inh-V</sub> 30 acre source area (mg/L)
	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)			GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)		
Chloroaniline, p-	4.6E-03	4.6E-01	9.8E-02	9.8E+00	6.8E+04	8.8E+03	1.0E-02	1.0E+00	2.9E-01	2.9E+01	9.5E+04	1.2E+04
Chlorobenzene					1.2E+03	1.5E+02					1.6E+03	2.1E+02
Chlorobenzilate	3.4E-03	3.4E-01	4.9E-01	4.9E+01	7.0E+03	9.0E+02	7.6E-03	7.6E-01	1.5E+00	1.5E+02	1.2E+04	1.5E+03
Chlorobromomethane (bromochloromethane)			9.8E-01	9.8E+01	2.2E+03	2.9E+02			2.9E+00	2.9E+02	3.1E+03	4.1E+02
Chlorodifluoromethane					1.7E+05	2.2E+04					2.4E+05	3.1E+04
Chloroethane (ethyl chloride)			9.8E+00	9.8E+02	1.2E+05	1.5E+04			2.9E+01	2.9E+03	1.6E+05	2.1E+04
Chloroethanol, 2-			9.8E+00	9.8E+02	3.6E+04	4.6E+03			2.9E+01	2.9E+03	5.0E+04	6.5E+03
Chloroethoxy ethene, 2- (2-chloroethylvinylether)	8.3E-04	8.3E-02	4.9E-02	4.9E+00	2.0E+01	2.5E+00	1.9E-03	1.9E-01	1.5E-01	1.5E+01	2.7E+01	3.5E+00
Chloroform <sup>3</sup>			2.4E-01	2.4E+01	2.0E+01	2.6E+00			7.3E-01	7.3E+01	3.3E+01	4.3E+00
Chlorohexane, 1-			9.8E-01	9.8E+01	7.3E+03	9.4E+02			2.9E+00	2.9E+02	1.0E+04	1.3E+03
Chloromethane (methyl chloride)	7.0E-02	7.0E+00			3.6E+01	4.7E+00	1.6E-01	1.6E+01			6.1E+01	7.9E+00
Chloronaphthalene, 1- (Chloronaphthalene, alpha-)			2.0E+00	2.0E+02					5.8E+00	5.8E+02		
Chloronaphthalene, 2- (chloronaphthalene, beta)			2.0E+00	2.0E+02					5.8E+00	5.8E+02		
Chloronitrobenzene, p- (1-chloro-4-nitrobenzene)	1.4E-01	1.4E+01	2.4E-02	2.4E+00	7.6E+02	9.9E+01	3.2E-01	3.2E+01	7.3E-02	7.3E+00	1.1E+03	1.4E+02
Chlorophenol, 2-			1.2E-01	1.2E+01	6.2E+04	8.0E+03			3.7E-01	3.7E+01	8.6E+04	1.1E+04
Chlorophenol, 3-			1.2E-01	1.2E+01	5.9E+05	7.7E+04			3.7E-01	3.7E+01	8.3E+05	1.1E+05
Chlorophenol, 4-			1.2E-01	1.2E+01	5.8E+05	7.5E+04			3.7E-01	3.7E+01	8.2E+05	1.1E+05
Chlorophenyl phenylether, 4-	6.1E-05	6.1E-03			1.2E+00	1.6E-01	1.4E-04	1.4E-02			2.1E+00	2.7E-01
Chloropropane, 2-			7.3E-01	7.3E+01	4.7E+02	6.0E+01			2.2E+00	2.2E+02	6.5E+02	8.5E+01
Chlorothalonil	8.3E-02	8.3E+00	3.7E-01	3.7E+01			1.9E-01	1.9E+01	1.1E+00	1.1E+02		
Chlorotoluene, o- (2-chlorotoluene)			4.9E-01	4.9E+01	7.7E+03	9.9E+02			1.5E+00	1.5E+02	1.1E+04	1.4E+03
Chlorotoluene, p- (4-chlorotoluene)			1.7E+00	1.7E+02	7.9E+00	1.0E+00			5.1E+00	5.1E+02	1.1E+01	1.4E+00
Chlorpyrifos			7.3E-02	7.3E+00	1.6E+03	2.1E+02			2.2E-01	2.2E+01	2.2E+03	2.9E+02
Chromium (III)												
Chromium (total)												
Chromium (VI)												
Chrysene	1.3E-01	1.3E+01			5.8E+05	7.5E+04	2.8E-01	2.8E+01			9.8E+05	1.3E+05
Cobalt			7.3E-03	7.3E-01					2.2E-02	2.2E+00		
Copolymer acrylamide			4.9E-03	4.9E-01	4.8E+02	6.5E+01			1.5E-02	1.5E+00	6.8E+02	9.0E+01
Copper												
Coronene			4.9E-02	4.9E+00					1.5E-01	1.5E+01		
Coumaphos			1.7E-01	1.7E+01					5.1E-01	5.1E+01		
Cresol			1.2E+00	1.2E+02	1.2E+05	1.6E+04			3.7E+00	3.7E+02	1.7E+05	2.2E+04
Cresol, m- (3-methylphenol)			1.2E+00	1.2E+02	1.2E+05	1.6E+04			3.7E+00	3.7E+02	1.7E+05	2.2E+04

**Table 8**  
**Individual Tier 1 Groundwater PCLs**  
**Residential and Commercial/Industrial**

	Residential						Commercial/Industrial					
	Carcinogenic		Noncarcinogenic				Carcinogenic		Noncarcinogenic			
Chemical of Concern	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	Air <sup>Air</sup> GW <sub>Inh-V</sub> <sup>0.5 acre</sup> source area (mg/L)	Air <sup>Air</sup> GW <sub>Inh-V</sub> <sup>30 acre</sup> source area (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	Air <sup>Air</sup> GW <sub>Inh-V</sub> <sup>0.5 acre</sup> source area (mg/L)	Air <sup>Air</sup> GW <sub>Inh-V</sub> <sup>30 acre</sup> source area (mg/L)
Cresol, o- (2-methylphenol)			1.2E+00	1.2E+02	1.0E+05	1.3E+04			3.7E+00	3.7E+02	1.4E+05	1.8E+04
Cresol, p- (4-methylphenol)			1.2E-01	1.2E+01	1.2E+05	1.5E+04			3.7E-01	3.7E+01	1.7E+05	2.1E+04
Crotonaldehyde	4.8E-04	4.8E-02			6.3E+03	8.2E+02	1.1E-03	1.1E-01			8.9E+03	1.1E+03
Cumene (isopropylbenzene)			2.4E+00	2.4E+02	4.4E+03	5.7E+02			7.3E+00	7.3E+02	6.2E+03	8.0E+02
Cyanazine	1.1E-03	1.1E-01	4.9E-02	4.9E+00			2.4E-03	2.4E-01	1.5E-01	1.5E+01		
Cyanide												
Cyanogen			9.8E-01	9.8E+01	1.9E+02	2.5E+01			2.9E+00	2.9E+02	2.7E+02	3.5E+01
Cycloate			1.3E+00	1.3E+02					4.0E+00	4.0E+02		
Cyclohexane			1.2E+02	1.2E+04	5.9E+03	7.7E+02			3.7E+02	3.7E+04	8.3E+03	1.1E+03
Cyclohexanol			1.2E+02	1.2E+04	2.7E+06	3.6E+05			3.7E+02	3.7E+04	3.8E+06	5.0E+05
Cyclohexanone			1.2E+02	1.2E+04	2.0E+05	2.6E+04			3.7E+02	3.7E+04	2.8E+05	3.6E+04
Cyclohexene-1-methanol, 3-			4.9E-01	4.9E+01					1.5E+00	1.5E+02		
Cyclopentane, methyl-			2.4E+00	2.4E+02	6.8E+02	8.8E+01			7.3E+00	7.3E+02	9.5E+02	1.2E+02
Cyclotetramethylenetetranitramine (HMX)			1.2E+00	1.2E+02	1.1E+08	1.1E+08			3.7E+00	3.7E+02	1.6E+08	1.6E+08
Cyclotrimethylenetrinitramine (RDX)	8.3E-03	8.3E-01	7.3E-02	7.3E+00	1.2E+03	1.5E+02	1.9E-02	1.9E+00	2.2E-01	2.2E+01	1.6E+03	2.1E+02
Cymene (isopropyltoluene)			2.4E+00	2.4E+02	4.6E+03	5.9E+02			7.3E+00	7.3E+02	6.4E+03	8.3E+02
Cymoxanil			3.2E-01	3.2E+01					9.5E-01	9.5E+01		
Dacthal (DCPA)			2.4E-01	2.4E+01					7.3E-01	7.3E+01		
Dalapon, sodium salt (2,2-dichloropropanoic acid)												
DDD	3.8E-03	3.8E-01					8.5E-03	8.5E-01				
DDE	2.7E-03	2.7E-01					6.0E-03	6.0E-01				
DDT	2.7E-03	2.7E-01	1.2E-02	1.2E+00	6.2E+02	8.1E+01	6.0E-03	6.0E-01	3.7E-02	3.7E+00	1.0E+03	1.4E+02
Demeton			9.8E-04	9.8E-02					2.9E-03	2.9E-01		
Diacetone alcohol (4-hydroxy-4-methyl-2-pentanone)			9.8E-01	9.8E+01					2.9E+00	2.9E+02		
Diallate	1.5E-02	1.5E+00					3.4E-02	3.4E+00				
Diazinon			2.2E-02	2.2E+00	4.0E+03	5.2E+02			6.6E-02	6.6E+00	5.6E+03	7.2E+02
Dibenz(a,h)acridine	7.6E-04	7.6E-02			8.1E+03	1.1E+03	1.7E-03	1.7E-01			1.4E+04	1.8E+03
Dibenz(a,j)acridine	1.3E-03	1.3E-01			1.0E+04	1.3E+03	2.8E-03	2.8E-01			1.7E+04	2.2E+03
Dibenz-a,h-anthracene	2.0E-04	2.0E-02			1.0E+03	1.3E+02	2.8E-04	2.8E-02			1.8E+03	2.3E+02
Dibenzo(a,e)pyrene	1.3E-04	1.3E-02			1.0E+03	1.3E+02	2.8E-04	2.8E-02			1.7E+03	2.2E+02
Dibenzo(a,h)pyrene	1.3E-05	1.3E-03			1.0E+02	1.3E+01	2.8E-05	2.8E-03			1.7E+02	2.2E+01
Dibenzo(a,i)pyrene	1.3E-05	1.3E-03			1.0E+02	1.3E+01	2.8E-05	2.8E-03			1.7E+02	2.2E+01
Dibenzofuran			9.8E-02	9.8E+00					2.9E-01	2.9E+01		
Dibenzothiophene			7.3E-02	7.3E+00					2.2E-01	2.2E+01		

**Table 8**  
**Individual Tier 1 Groundwater PCLs**  
**Residential and Commercial/Industrial**

	Residential						Commercial/Industrial					
	Carcinogenic		Noncarcinogenic				Carcinogenic		Noncarcinogenic			
Chemical of Concern					Air GW <sub>Inh-V</sub> 0.5 acre source area (mg/L)	Air GW <sub>Inh-V</sub> 30 acre source area (mg/L)					Air GW <sub>Inh-V</sub> 0.5 acre source area (mg/L)	Air GW <sub>Inh-V</sub> 30 acre source area (mg/L)
	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)			GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)		
Dibromo-3-chloropropane, 1,2-					6.2E-01	8.0E-02					1.0E+00	1.3E-01
Dibromochloromethane (chlorodibromomethane) <sup>3</sup>	1.1E-02	1.1E+00	4.9E-01	4.9E+01			2.4E-02	2.4E+00	1.5E+00	1.5E+02		
Dibromofluoromethane			4.9E+00	4.9E+02	1.3E+05	1.7E+04			1.5E+01	1.5E+03	1.8E+05	2.4E+04
Dicamba			7.3E-01	7.3E+01	3.0E+05	3.9E+04			2.2E+00	2.2E+02	4.2E+05	5.5E+04
Dichlormid			6.1E-01	6.1E+01					1.8E+00	1.8E+02		
Dichloro-2-butene, 1,4-					6.7E-01	8.7E-02					1.1E+00	1.5E-01
Dichloro-2-butene, 1,4- trans					6.5E-01	8.5E-02					1.1E+00	1.4E-01
Dichlorobenzene, 1,2-					1.2E+03	1.5E+02					1.6E+03	2.1E+02
Dichlorobenzene, 1,3-			7.3E-01	7.3E+01	1.9E+02	2.5E+01			2.2E+00	2.2E+02	2.7E+02	3.4E+01
Dichlorobenzene, 1,4-					3.6E+03	4.6E+02					5.0E+03	6.5E+02
Dichlorobenzidine, 3,3-	2.0E-03	2.0E-01					4.5E-03	4.5E-01				
Dichlorobutane, 2,3-			2.4E-01	2.4E+01	1.4E+02	1.9E+01			7.3E-01	7.3E+01	2.0E+02	2.6E+01
Dichlorodifluoromethane			4.9E+00	4.9E+02	3.0E+03	3.8E+02			1.5E+01	1.5E+03	4.2E+03	5.4E+02
Dichloroethane, 1,1-			4.9E+00	4.9E+02	7.2E+03	9.3E+02			1.5E+01	1.5E+03	1.0E+04	1.3E+03
Dichloroethane, 1,2-					3.3E+01	4.3E+00					5.5E+01	7.2E+00
Dichloroethylene, 1,1-					1.7E+03	2.2E+02					2.3E+03	3.0E+02
Dichloroethylene, cis-1,2-					1.6E+04	2.1E+03					2.3E+04	2.9E+03
Dichloroethylene, trans-1,2					7.7E+02	9.9E+01					1.1E+03	1.4E+02
Dichlorofluoromethane			4.9E+00	4.9E+02	7.2E+02	9.3E+01			1.5E+01	1.5E+03	1.0E+03	1.3E+02
Dichlorophenol, 2,3-			7.3E-02	7.3E+00	1.1E+06	1.4E+05			2.2E-01	2.2E+01	1.6E+06	2.0E+05
Dichlorophenol, 2,4-			7.3E-02	7.3E+00	5.4E+05	7.0E+04			2.2E-01	2.2E+01	7.6E+05	9.8E+04
Dichlorophenol, 2,5-			7.3E-02	7.3E+00	1.1E+06	1.4E+05			2.2E-01	2.2E+01	1.6E+06	2.0E+05
Dichlorophenol, 2,6-			2.4E-02	2.4E+00	3.7E+05	4.7E+04			7.3E-02	7.3E+00	5.1E+05	6.6E+04
Dichlorophenol, 3,4-			7.3E-02	7.3E+00	1.3E+06	1.6E+05			2.2E-01	2.2E+01	1.8E+06	2.3E+05
Dichlorophenol, 3,5-			7.3E-02	7.3E+00	1.2E+06	1.6E+05			2.2E-01	2.2E+01	1.7E+06	2.2E+05
Dichlorophenoxy, 2,4- butyric acid, 4- (2,4-DB)			2.0E-01	2.0E+01					5.8E-01	5.8E+01		
Dichlorophenoxyacetic acid, 2,4- (2,4-D)					3.2E+04	4.2E+03					4.4E+04	5.9E+03
Dichloroprop (2-(2,4-dichlorophenoxy) propanoic acid)			2.4E-01	2.4E+01					7.3E-01	7.3E+01		
Dichloropropane, 1,2-					1.2E+02	1.5E+01					1.6E+02	2.1E+01
Dichloropropane, 1,3-	9.1E-03	9.1E-01	4.9E-01	4.9E+01	2.5E+02	3.3E+01	2.0E-02	2.0E+00	1.5E+00	1.5E+02	4.3E+02	5.5E+01
Dichloropropane, 2,2-	1.3E-02	1.3E+00	2.2E+00	2.2E+02	5.7E+01	7.3E+00	3.0E-02	3.0E+00	6.6E+00	6.6E+02	7.9E+01	1.0E+01
Dichloropropanol, 2,3-			7.3E-02	7.3E+00					2.2E-01	2.2E+01		
Dichloropropene, 1,1-	9.1E-03	9.1E-01	7.3E-01	7.3E+01	1.9E+01	2.5E+00	2.0E-02	2.0E+00	2.2E+00	2.2E+02	3.2E+01	4.2E+00
Dichloropropene, 1,3- (mixed isomers)	9.1E-03	9.1E-01	7.3E-01	7.3E+01	1.8E+02	2.3E+01	2.0E-02	2.0E+00	2.2E+00	2.2E+02	3.0E+02	3.8E+01

**Table 8**  
**Individual Tier 1 Groundwater PCLs**  
**Residential and Commercial/Industrial**

	Residential						Commercial/Industrial					
	Carcinogenic		Noncarcinogenic				Carcinogenic		Noncarcinogenic			
Chemical of Concern					Air GW <sub>Inh-V</sub> 0.5 acre source area (mg/L)	Air GW <sub>Inh-V</sub> 30 acre source area (mg/L)					Air GW <sub>Inh-V</sub> 0.5 acre source area (mg/L)	Air GW <sub>Inh-V</sub> 30 acre source area (mg/L)
	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)			GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)		
Dichloropropene, cis 1,3-	1.7E-03	1.7E-01	2.4E-03	2.4E-01	2.3E+02	3.0E+01	3.8E-03	3.8E-01	7.3E-03	7.3E-01	3.2E+02	4.2E+01
Dichloropropene, trans 1,3-	9.1E-03	9.1E-01	7.3E-01	7.3E+01	1.9E+02	2.5E+01	2.0E-02	2.0E+00	2.2E+00	2.2E+02	3.2E+02	4.1E+01
Dichlorvos	3.1E-03	3.1E-01	1.2E-02	1.2E+00	1.0E+04	1.3E+03	7.0E-03	7.0E-01	3.7E-02	3.7E+00	1.4E+04	1.8E+03
Dicrotophos (bidrin)			2.4E-03	2.4E-01					7.3E-03	7.3E-01		
Dicyclopentadiene			2.0E-01	2.0E+01					5.8E-01	5.8E+01		
Dieldrin	5.7E-05	5.7E-03	1.2E-03	1.2E-01	1.3E+02	1.6E+01	1.3E-04	1.3E-02	3.7E-03	3.7E-01	2.1E+02	2.8E+01
Diethanolamine			1.2E-02	1.2E+00	1.5E+05	1.2E+05			3.7E-02	3.7E+00	2.2E+05	1.6E+05
Diethyl phthalate			2.0E+01	2.0E+03	1.4E+05	1.8E+04			5.8E+01	5.8E+03	1.9E+05	2.5E+04
Diethylene glycol			4.9E+01	4.9E+03					1.5E+02	1.5E+04		
Diethylene glycol monobutyl ether			7.3E-01	7.3E+01	3.2E+03	4.1E+02			2.2E+00	2.2E+02	4.5E+03	5.8E+02
Diethylhexyl adipate					1.7E+03	2.1E+02					2.3E+03	3.0E+02
Diethylstilbestrol	1.9E-07	1.9E-05					4.3E-07	4.3E-05				
Diisobutylene (trimethyl-1-pentene, 2,4,4-)			1.5E+00	1.5E+02	2.3E+01	3.0E+00			4.4E+00	4.4E+02	3.2E+01	4.2E+00
Diisopropylbenzene, p-			2.4E-01	2.4E+01	1.3E+03	1.7E+02			7.3E-01	7.3E+01	1.8E+03	2.3E+02
Diisopropyl ether (2,2'-oxybis-propane)			2.4E+00	2.4E+02	1.1E+04	1.4E+03			7.3E+00	7.3E+02	1.6E+04	2.0E+03
Dimethenamid			3.7E-01	3.7E+01					1.1E+00	1.1E+02		
Dimethoate			4.9E-03	4.9E-01					1.5E-02	1.5E+00		
Dimethoxybenzidine, 3,3'-	6.5E-02	6.5E+00					1.5E-01	1.5E+01				
Dimethylphenethylamine, alpha, alpha-			4.9E-02	4.9E+00	7.2E+06	9.4E+05			1.5E-01	1.5E+01	1.0E+07	1.3E+06
Dimethyl phenol, 2,4-			4.9E-01	4.9E+01	1.6E+05	2.1E+04			1.5E+00	1.5E+02	2.3E+05	3.0E+04
Dimethylaminoazobenzene, p-			2.4E-04	2.4E-02					7.3E-04	7.3E-02		
Dimethylbenz-a-anthracene, 7,12-	3.7E-06	3.7E-04			3.3E+01	4.3E+00	8.2E-06	8.2E-04			5.5E+01	7.2E+00
Dimethylbenzidine, 3,3'-	8.3E-05	8.3E-03					1.9E-04	1.9E-02				
Dimethylnaphthalene, 1,3-			9.8E-01	9.8E+01					2.9E+00	2.9E+02		
Dimethylphthalate			2.0E+01	2.0E+03	1.1E+05	1.4E+04			5.8E+01	5.8E+03	1.5E+05	1.9E+04
Di-n-butyl phthalate			2.4E+00	2.4E+02	7.2E+04	9.3E+03			7.3E+00	7.3E+02	1.0E+05	1.3E+04
Dinitro-2-methylphenol, 4,6- (dinitro-o-cresol, 4, 6-)			2.4E-03	2.4E-01	8.4E+03	1.1E+03			7.3E-03	7.3E-01	1.2E+04	1.5E+03
Dinitrobenzene, 1,3- (dinitrobenzene, 2,4- )			2.4E-03	2.4E-01	1.9E+04	2.5E+03			7.3E-03	7.3E-01	2.7E+04	3.4E+03
Dinitrobenzene, 1,4-			2.4E-03	2.4E-01	2.6E+04	3.4E+03			7.3E-03	7.3E-01	3.6E+04	4.7E+03
Dinitrophenol, 2,4-			4.9E-02	4.9E+00					1.5E-01	1.5E+01		
Dinitrophenol, 2,5-			4.9E-02	4.9E+00					1.5E-01	1.5E+01		
Dinitrotoluene, 2,4-	1.3E-03	1.3E-01	4.9E-02	4.9E+00	1.2E+03	1.6E+02	3.0E-03	3.0E-01	1.5E-01	1.5E+01	1.7E+03	2.2E+02
Dinitrotoluene, 2,6-	1.3E-03	1.3E-01	2.4E-02	2.4E+00	3.1E+03	4.1E+02	3.0E-03	3.0E-01	7.3E-02	7.3E+00	4.4E+03	5.7E+02
Di-n-octyl phthalate			4.9E-01	4.9E+01	9.9E+03	1.3E+03			1.5E+00	1.5E+02	1.4E+04	1.8E+03

**Table 8**  
**Individual Tier 1 Groundwater PCLs**  
**Residential and Commercial/Industrial**

	Residential						Commercial/Industrial					
	Carcinogenic		Noncarcinogenic				Carcinogenic		Noncarcinogenic			
Chemical of Concern					Air GW <sub>Inh-V</sub> 0.5 acre source area	Air GW <sub>Inh-V</sub> 30 acre source area					Air GW <sub>Inh-V</sub> 0.5 acre source area	Air GW <sub>Inh-V</sub> 30 acre source area
	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	(mg/L)	(mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	(mg/L)	(mg/L)
Dinoseb												
Dioxane 1,4-	8.3E-02	8.3E+00	2.4E+00	2.4E+02	1.5E+05	1.9E+04	1.9E-01	1.9E+01	7.3E+00	7.3E+02	2.1E+05	2.7E+04
Diphenyl ether			1.5E-01	1.5E+01	9.0E+02	1.2E+02			4.5E-01	4.5E+01	1.3E+03	1.6E+02
Diphenylamine			6.1E-01	6.1E+01	5.6E+04	7.2E+03			1.8E+00	1.8E+02	7.8E+04	1.0E+04
Diphenylhydrazine, 1,2-	1.1E-03	1.1E-01			3.8E+03	4.9E+02	2.6E-03	2.6E-01			6.4E+03	8.3E+02
Dipropylene glycol			2.9E+00	2.9E+02	3.6E+06	4.7E+05			8.8E+00	8.8E+02	5.0E+06	6.5E+05
Diquat					4.2E+04	3.9E+04					5.9E+04	5.5E+04
Disodium iminodiacetate (iminodiacetic acid, disodium salt)			2.4E-01	2.4E+01					7.3E-01	7.3E+01		
Disodium iminodiacetate (iminodiacetic acid, disodium salt)			2.4E-01	2.4E+01					7.3E-01	7.3E+01		
Disulfoton			9.8E-04	9.8E-02	3.5E+02	4.5E+01			2.9E-03	2.9E-01	4.9E+02	6.3E+01
Diuron			4.9E-02	4.9E+00	3.9E+05	5.0E+04			1.5E-01	1.5E+01	5.4E+05	7.0E+04
Dodecylphenol, 4-			1.2E+00	1.2E+02	6.4E+05	8.2E+04			3.7E+00	3.7E+02	8.9E+05	1.2E+05
Dodecylphenol, 4-			1.2E+00	1.2E+02	6.4E+05	8.2E+04			3.7E+00	3.7E+02	8.9E+05	1.2E+05
Endosulfan			1.5E-01	1.5E+01	1.2E+03	1.5E+02			4.4E-01	4.4E+01	1.6E+03	2.1E+02
Endosulfan I			4.9E-02	4.9E+00	9.1E+02	1.2E+02			1.5E-01	1.5E+01	1.3E+03	1.6E+02
Endosulfan II			1.5E-01	1.5E+01					4.4E-01	4.4E+01		
Endosulfan sulfate			1.5E-01	1.5E+01					4.4E-01	4.4E+01		
Endothall												
Endrin					3.3E+03	4.2E+02					4.6E+03	5.9E+02
Endrin aldehyde			7.3E-03	7.3E-01					2.2E-02	2.2E+00		
Endrin ketone			7.3E-03	7.3E-01	2.8E+03	3.6E+02			2.2E-02	2.2E+00	3.9E+03	5.1E+02
Epichlorohydrin	9.2E-02	9.2E+00	1.5E-01	1.5E+01	7.1E+02	9.1E+01	2.1E-01	2.1E+01	4.4E-01	4.4E+01	9.9E+02	1.3E+02
EPN (o-ethyl o-(4-nitrophenyl)phenylphosphonothioate)			2.4E-04	2.4E-02					7.3E-04	7.3E-02		
Esfenvalerate			4.9E-02	4.9E+00					1.5E-01	1.5E+01		
Ethalfuralin (sonolan)	1.0E-02	1.0E+00	9.8E-01	9.8E+01			2.3E-02	2.3E+00	2.9E+00	2.9E+02		
Ethanol			8.1E+02	8.1E+04	4.3E+06	5.6E+05			2.4E+03	2.4E+05	6.0E+06	7.8E+05
Ethanol, 2-amino-			4.2E-02	4.2E+00	1.4E+05	1.8E+04			1.2E-01	1.2E+01	1.9E+05	2.5E+04
Ethanol, 2-(2-aminoethoxy)-			1.2E-02	1.2E+00	9.7E+05	1.3E+05			3.7E-02	3.7E+00	1.4E+06	1.8E+05
Ethanol, 2-(2-ethoxyethoxy)-			4.9E+01	4.9E+03					1.5E+02	1.5E+04		
Ethion			1.2E-02	1.2E+00	1.2E+04	1.5E+03			3.7E-02	3.7E+00	1.7E+04	2.2E+03
Ethoprop	3.2E-02	3.2E+00	2.4E-03	2.4E-01			7.3E-02	7.3E+00	7.3E-03	7.3E-01		
Ethoxy ethanol, 2-			9.8E+00	9.8E+02	4.9E+02	6.4E+01			2.9E+01	2.9E+03	6.9E+02	9.0E+01
Ethyl acetate			2.2E+01	2.2E+03	3.3E+05	4.3E+04			6.6E+01	6.6E+03	4.7E+05	6.0E+04
Ethyl acrylate	1.9E-02	1.9E+00			2.2E+03	2.8E+02	4.3E-02	4.3E+00			3.1E+03	4.0E+02

**Table 8**  
**Individual Tier 1 Groundwater PCLs**  
**Residential and Commercial/Industrial**

	Residential						Commercial/Industrial					
	Carcinogenic		Noncarcinogenic				Carcinogenic		Noncarcinogenic			
Chemical of Concern	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	Air <sup>Air</sup> GW <sub>Inh-V</sub> 0.5 acre	Air <sup>Air</sup> GW <sub>Inh-V</sub> 30 acre	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	Air <sup>Air</sup> GW <sub>Inh-V</sub> 0.5 acre	Air <sup>Air</sup> GW <sub>Inh-V</sub> 30 acre
					source area (mg/L)	source area (mg/L)					source area (mg/L)	source area (mg/L)
Ethyl benzene					1.6E+04	2.0E+03					2.2E+04	2.8E+03
Ethyl dipropylthiocarbamate, S-			6.1E-01	6.1E+01					1.8E+00	1.8E+02		
Ethyl ether			4.9E+00	4.9E+02	8.4E+04	1.1E+04			1.5E+01	1.5E+03	1.2E+05	1.5E+04
Ethyl methacrylate			2.2E+00	2.2E+02	9.5E+04	1.2E+04			6.6E+00	6.6E+02	1.3E+05	1.7E+04
Ethyl methanesulfonate	9.2E-03	9.2E-01			1.9E+04	2.4E+03	2.1E-02	2.1E+00			3.1E+04	4.0E+03
Ethyl tert-butyl ether (2-ethyl-2-ethoxypropane)			2.4E-02	2.4E+00	1.1E+04	1.4E+03			7.3E-02	7.3E+00	1.5E+04	2.0E+03
Ethyl-1-hexanol, 2-			3.7E+00	3.7E+02	2.6E+05	3.3E+04			1.1E+01	1.1E+03	3.6E+05	4.7E+04
Ethyl-2-hexenal, 2-			3.7E+00	3.7E+02	1.9E+04	2.4E+03			1.1E+01	1.1E+03	2.6E+04	3.4E+03
Ethyl-2-methyl benzene, 1-			4.9E+00	4.9E+02	9.2E+03	1.2E+03			1.5E+01	1.5E+03	1.3E+04	1.7E+03
Ethyl-4-methyl benzene, 1-			4.9E+00	4.9E+02	7.0E+03	9.0E+02			1.5E+01	1.5E+03	9.7E+03	1.3E+03
Ethylene*												
Ethylene dibromide (dibromoethane, 1,2- )					5.6E+00	7.2E-01					9.4E+00	1.2E+00
Ethylene glycol			4.9E+01	4.9E+03	4.1E+05	5.3E+04			1.5E+02	1.5E+04	5.8E+05	7.5E+04
Ethylene oxide	8.9E-04	8.9E-02			4.2E+01	5.4E+00	2.0E-03	2.0E-01			7.0E+01	9.1E+00
Ethylene thiourea	8.3E-03	8.3E-01	2.0E-03	2.0E-01	5.4E+04	7.0E+03	1.9E-02	1.9E+00	5.8E-03	5.8E-01	7.5E+04	9.7E+03
Ethylenediamine			2.2E+00	2.2E+02	4.6E+05	5.9E+04			6.6E+00	6.6E+02	6.4E+05	8.3E+04
Ethylenimine	1.4E-05	1.4E-03			1.4E+01	1.8E+00	3.1E-05	3.1E-03			2.3E+01	3.0E+00
Ethylhexyl acrylate, 2-	1.9E-02	1.9E+00			1.3E+03	1.7E+02	4.3E-02	4.3E+00			1.9E+03	2.4E+02
Famphur			7.3E-04	7.3E-02	5.4E+04	2.1E+04			2.2E-03	2.2E-01	7.6E+04	2.9E+04
Fensulfothion			2.4E-02	2.4E+00					7.3E-02	7.3E+00		
Fenthion			1.7E-03	1.7E-01					5.1E-03	5.1E-01		
Fluoranthene			9.8E-01	9.8E+01					2.9E+00	2.9E+02		
Fluorene			9.8E-01	9.8E+01					2.9E+00	2.9E+02		
Fluorine (soluble fluoride)												
Fluorochloridone			1.8E-01	1.8E+01	3.7E+05	4.8E+04			5.5E-01	5.5E+01	5.2E+05	6.8E+04
Fonofos			4.9E-02	4.9E+00					1.5E-01	1.5E+01		
Formaldehyde			4.9E+00	4.9E+02	8.6E+04	1.1E+04			1.5E+01	1.5E+03	1.2E+05	1.6E+04
Formic acid			4.9E+01	4.9E+03	1.7E+04	2.3E+03			1.5E+02	1.5E+04	2.4E+04	3.2E+03
Furan			2.4E-02	2.4E+00	4.0E+02	5.2E+01			7.3E-02	7.3E+00	5.6E+02	7.3E+01
Furfural			7.3E-02	7.3E+00	4.3E+04	5.6E+03			2.2E-01	2.2E+01	6.0E+04	7.8E+03
Glycidylaldehyde			9.8E-03	9.8E-01	1.4E+04	1.9E+03			2.9E-02	2.9E+00	2.0E+04	2.6E+03
Glyphosate												
Heptachlor					6.3E+00	8.1E-01					1.1E+01	1.4E+00
Heptachlor epoxide					1.2E+02	1.5E+01					2.0E+02	2.6E+01

**Table 8**  
**Individual Tier 1 Groundwater PCLs**  
**Residential and Commercial/Industrial**

	Residential						Commercial/Industrial					
	Carcinogenic		Noncarcinogenic				Carcinogenic		Noncarcinogenic			
Chemical of Concern					Air GW <sub>Inh-V</sub> 0.5 acre source area	Air GW <sub>Inh-V</sub> 30 acre source area					Air GW <sub>Inh-V</sub> 0.5 acre source area	Air GW <sub>Inh-V</sub> 30 acre source area
	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)			GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)		
Heptane, n-			1.5E+00	1.5E+02	1.7E+03	2.2E+02			4.4E+00	4.4E+02	2.4E+03	3.1E+02
Heptanoic acid, n-			1.2E+01	1.2E+03	1.7E+04	2.1E+03			3.7E+01	3.7E+03	2.3E+04	3.0E+03
Hexachlorobenzene					5.7E+00	7.4E-01					9.6E+00	1.2E+00
Hexachlorobutadiene	1.2E-02	1.2E+00	2.4E-02	2.4E+00	8.9E+00	1.1E+00	2.6E-02	2.6E+00	7.3E-02	7.3E+00	1.5E+01	1.9E+00
Hexachlorocyclohexane, alpha (alpha-BHC)	1.4E-04	1.4E-02	2.0E-01	2.0E+01	1.5E+02	2.0E+01	3.2E-04	3.2E-02	5.8E-01	5.8E+01	2.6E+02	3.3E+01
Hexachlorocyclohexane, beta (beta-BHC)	5.1E-04	5.1E-02			1.1E+03	1.5E+02	1.1E-03	1.1E-01			1.9E+03	2.5E+02
Hexachlorocyclohexane, delta (delta-BHC)	5.1E-04	5.1E-02	7.3E-03	7.3E-01	3.6E+02	4.7E+01	1.1E-03	1.1E-01	2.2E-02	2.2E+00	6.1E+02	7.9E+01
Hexachlorocyclohexane, gamma (lindane; gamma-BHC)					8.3E+03	1.1E+03					1.2E+04	1.5E+03
Hexachlorocyclohexane, techn (technical-BHC)	5.1E-04	5.1E-02			9.9E+02	1.3E+02	1.1E-03	1.1E-01			1.7E+03	2.2E+02
Hexachlorocyclopentadiene					5.4E+00	7.0E-01					7.6E+00	9.8E-01
Hexachloroethane	6.5E-02	6.5E+00	2.4E-02	2.4E+00	1.4E+03	1.8E+02	1.5E-01	1.5E+01	7.3E-02	7.3E+00	2.4E+03	3.1E+02
Hexachlorophene			7.3E-03	7.3E-01					2.2E-02	2.2E+00		
Hexachloropropylene	6.5E-02	6.5E+00	2.4E-02	2.4E+00	4.2E+02	5.4E+01	1.5E-01	1.5E+01	7.3E-02	7.3E+00	7.0E+02	9.1E+01
Hexanal, 2-ethyl-			3.7E+00	3.7E+02	2.2E+04	2.9E+03			1.1E+01	1.1E+03	3.1E+04	4.0E+03
Hexane, n-			1.5E+00	1.5E+02	3.8E+01	4.9E+00			4.4E+00	4.4E+02	5.3E+01	6.9E+00
Hexanediamine, 1,6-			1.2E-01	1.2E+01	6.9E+04	9.0E+03			3.7E-01	3.7E+01	9.7E+04	1.3E+04
Hexanedinitrile			3.4E-02	3.4E+00	1.6E+05	2.1E+04			1.0E-01	1.0E+01	2.2E+05	2.9E+04
Hexanediol, 1,6-			1.2E+02	1.2E+04	4.8E+08	6.3E+07			3.7E+02	3.7E+04	6.7E+08	8.8E+07
Hexanoic acid			1.6E+00	1.6E+02	2.1E+04	2.7E+03			4.7E+00	4.7E+02	3.0E+04	3.8E+03
Hexanone, 2-			1.2E-01	1.2E+01	1.2E+04	1.5E+03			3.7E-01	3.7E+01	1.6E+04	2.1E+03
Hexazinone			8.1E-01	8.1E+01	2.6E+05	8.6E+04			2.4E+00	2.4E+02	3.6E+05	1.2E+05
Hexene, 1-			2.4E+00	2.4E+02	4.0E+01	5.1E+00			7.3E+00	7.3E+02	5.6E+01	7.2E+00
Hexylene glycol (2-methyl-2,4-pentanediol)			7.3E+00	7.3E+02	3.9E+03	5.1E+02			2.2E+01	2.2E+03	5.5E+03	7.1E+02
Hydrazine	3.0E-04	3.0E-02			5.1E+01	6.7E+00	6.8E-04	6.8E-02			8.6E+01	1.1E+01
Hydrocaproic acid, 6- (6-hydroxyhexanoic acid)			1.6E+00	1.6E+02	2.9E+04	4.2E+03			4.7E+00	4.7E+02	4.0E+04	5.9E+03
Hydrogen chloride (hydrochloric acid)*												
Hydroquinone	1.5E-02	1.5E+00	9.8E-01	9.8E+01			3.4E-02	3.4E+00	2.9E+00	2.9E+02		
Indene			4.9E-01	4.9E+01	2.7E+02	3.5E+01			1.5E+00	1.5E+02	3.8E+02	5.0E+01
Indeno-1,2,3-cd-pyrene	1.3E-03	1.3E-01			9.4E+03	1.2E+03	2.8E-03	2.8E-01			1.6E+04	2.0E+03
Iron*												
Isomyl alcohol			1.2E-01	1.2E+01	6.8E+05	8.7E+04			3.7E-01	3.7E+01	9.5E+05	1.2E+05
Isobutyl alcohol			7.3E+00	7.3E+02	2.8E+05	3.6E+04			2.2E+01	2.2E+03	3.9E+05	5.0E+04
Isobutylene (2-methyl-1-propene)					6.1E+04	7.9E+03					8.5E+04	1.1E+04
Isobutyric acid (2-methylpropanoic acid)			1.2E+01	1.2E+03	1.5E+04	1.9E+03			3.7E+01	3.7E+03	2.1E+04	2.7E+03

**Table 8**  
**Individual Tier 1 Groundwater PCLs**  
**Residential and Commercial/Industrial**

	Residential						Commercial/Industrial					
	Carcinogenic		Noncarcinogenic				Carcinogenic	Noncarcinogenic				
Chemical of Concern					Air GW <sub>Inh-V</sub> 0.5 acre source area	Air GW <sub>Inh-V</sub> 30 acre source area					Air GW <sub>Inh-V</sub> 0.5 acre source area	Air GW <sub>Inh-V</sub> 30 acre source area
	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	(mg/L)	(mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	(mg/L)	(mg/L)
Isodecanol			3.9E-02	3.9E+00					1.2E-01	1.2E+01		
Isodrin	5.4E-06	5.4E-04	7.3E-05	7.3E-03	3.4E-02	4.4E-03	1.2E-05	1.2E-03	2.2E-04	2.2E-02	5.7E-02	7.4E-03
Isophorone	9.6E-01	9.6E+01	4.9E+00	4.9E+02	1.0E+05	1.3E+04	2.2E+00	2.2E+02	1.5E+01	1.5E+03	1.4E+05	1.9E+04
Isopropyl acetate			1.7E+00	1.7E+02					5.1E+00	5.1E+02		
Isopropyl alcohol			4.9E+00	4.9E+02	1.5E+06	1.9E+05			1.5E+01	1.5E+03	2.1E+06	2.7E+05
Isosafrole	4.1E-03	4.1E-01			4.3E+02	5.5E+01	9.3E-03	9.3E-01			7.2E+02	9.3E+01
Kelthane (dicofol)			1.5E-01	1.5E+01					4.4E-01	4.4E+01		
Kepone (chlordecone)	9.1E-05	9.1E-03	7.3E-03	7.3E-01	2.4E+02	3.0E+01	2.0E-04	2.0E-02	2.2E-02	2.2E+00	4.0E+02	5.1E+01
Lead (inorganic)												
Limonene, d-*												
Lithium			4.9E-02	4.9E+00					1.5E-01	1.5E+01		
Magnesium*												
Malathion			4.9E-01	4.9E+01	2.3E+05	3.0E+04			1.5E+00	1.5E+02	3.2E+05	4.2E+04
Maleic anhydride			2.4E+00	2.4E+02	1.6E+04	2.0E+03			7.3E+00	7.3E+02	2.2E+04	2.8E+03
Maleic hydrazide			1.2E+01	1.2E+03	3.3E+06	1.3E+06			3.7E+01	3.7E+03	4.7E+06	1.8E+06
Malononitrile			2.4E-03	2.4E-01	1.5E+05	1.9E+04			7.3E-03	7.3E-01	2.1E+05	2.7E+04
Mancozeb			7.3E-01	7.3E+01					2.2E+00	2.2E+02		
Manganese			1.1E+00	1.1E+02					1.0E+01	1.0E+03		
MCPA (4-(chloro-2-methylphenoxy) acetic acid)			1.2E-02	1.2E+00					3.7E-02	3.7E+00		
MCPP (2-(4-chloro-2-methylphenoxy) propanoic acid)			2.4E-02	2.4E+00					7.3E-02	7.3E+00		
MCPP (2-(4-chloro-2-methylphenoxy) propanoic acid)			2.4E-02	2.4E+00					7.3E-02	7.3E+00		
MCP (2-(4-chloro-2-methylphenoxy) propanoic acid)			2.4E-02	2.4E+00					7.3E-02	7.3E+00		
Mercuric chloride (pH = 4.9)					7.3E+00	9.4E-01					1.0E+01	1.3E+00
Mercuric chloride (pH = 6.8)					7.3E+00	9.4E-01					1.0E+01	1.3E+00
Mercury (pH = 4.9)					7.3E+00	9.4E-01					1.0E+01	1.3E+00
Merphos			7.3E-04	7.3E-02					2.2E-03	2.2E-01		
Methacrylic acid (2-methyl-2-propenoic acid)			2.4E-01	2.4E+01	1.2E+05	1.6E+04			7.3E-01	7.3E+01	1.7E+05	2.2E+04
Methacrylonitrile			2.4E-03	2.4E-01	1.0E+03	1.3E+02			7.3E-03	7.3E-01	1.4E+03	1.8E+02
Methanol			1.2E+01	1.2E+03	6.1E+05	7.9E+04			3.7E+01	3.7E+03	8.6E+05	1.1E+05
Methapyrilene	1.9E-04	1.9E-02			1.2E+04	1.5E+03	4.3E-04	4.3E-02			1.6E+04	2.1E+03
Methomyl			6.1E-01	6.1E+01	7.1E+04	9.5E+03			1.8E+00	1.8E+02	1.0E+05	1.3E+04
Methoxychlor					3.5E+04	4.5E+03					4.8E+04	6.3E+03
Methoxyethanol, 2-					8.1E+01	1.1E+01					1.1E+02	1.5E+01
Methyl acetate (acetic acid, methyl ester)			2.4E+01	2.4E+03	1.3E+05	1.7E+04			7.3E+01	7.3E+03	1.9E+05	2.4E+04

**Table 8**  
**Individual Tier 1 Groundwater PCLs**  
**Residential and Commercial/Industrial**

	Residential						Commercial/Industrial					
	Carcinogenic		Noncarcinogenic				Carcinogenic		Noncarcinogenic			
Chemical of Concern	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	AirGW <sub>Inh-V</sub> <sup>0.5 acre</sup> source area (mg/L)	AirGW <sub>Inh-V</sub> <sup>30 acre</sup> source area (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	AirGW <sub>Inh-V</sub> <sup>0.5 acre</sup> source area (mg/L)	AirGW <sub>Inh-V</sub> <sup>30 acre</sup> source area (mg/L)
Methyl acrylate			4.9E-02	4.9E+00	9.3E+02	1.2E+02			1.5E-01	1.5E+01	1.3E+03	1.7E+02
Methyl amyl ketone (2-heptanone)			1.2E+00	1.2E+02	1.1E+06	1.4E+05			3.7E+00	3.7E+02	1.5E+06	2.0E+05
Methyl chrysene, 1-	1.3E-01	1.3E+01			8.0E+05	1.0E+05	2.8E-01	2.8E+01			1.3E+06	1.7E+05
Methyl chrysene, 2-	1.3E-01	1.3E+01			8.0E+05	1.0E+05	2.8E-01	2.8E+01			1.3E+06	1.7E+05
Methyl chrysene, 6-	1.3E-02	1.3E+00			8.0E+04	1.0E+04	2.8E-02	2.8E+00			1.3E+05	1.7E+04
Methyl cyclohexane			1.2E+02	1.2E+04	1.4E+03	1.8E+02			3.7E+02	3.7E+04	2.0E+03	2.6E+02
Methyl ethyl ketone (2-butanone)			1.5E+01	1.5E+03	2.7E+06	3.5E+05			4.4E+01	4.4E+03	3.8E+06	4.9E+05
Methyl iodide (iodomethane)			3.4E-02	3.4E+00	1.7E+02	2.2E+01			1.0E-01	1.0E+01	2.4E+02	3.1E+01
Methyl isobutyl ketone (4-methyl-2-pentanone)			2.0E+00	2.0E+02	6.7E+05	8.7E+04			5.8E+00	5.8E+02	9.4E+05	1.2E+05
Methyl mercury			2.4E-03	2.4E-01					7.3E-03	7.3E-01		
Methyl methacrylate			3.4E+01	3.4E+03	7.9E+04	1.0E+04			1.0E+02	1.0E+04	1.1E+05	1.4E+04
Methyl methanesulfonate	9.2E-03	9.2E-01			1.7E+04	2.2E+03	2.1E-02	2.1E+00			2.8E+04	3.7E+03
Methyl parathion			6.1E-03	6.1E-01	4.5E+03	5.8E+02			1.8E-02	1.8E+00	6.3E+03	8.1E+02
Methyl-1-butene, 2-			1.5E+00	1.5E+02	7.8E+03	1.0E+03			4.4E+00	4.4E+02	1.1E+04	1.4E+03
Methyl-1-propanal, 2- (isobutyraldehyde)			9.8E-01	9.8E+01	4.5E+04	5.8E+03			2.9E+00	2.9E+02	6.2E+04	8.1E+03
Methyl-2-butene, 2-			1.5E+00	1.5E+02	1.5E+04	1.9E+03			4.4E+00	4.4E+02	2.1E+04	2.7E+03
Methyl-2-pentenal, 2-	4.8E-04	4.8E-02			7.2E+02	9.3E+01	1.1E-03	1.1E-01			1.0E+03	1.3E+02
Methyl-5-nitroaniline, 2- (5-nitro-o-toluidine)	2.8E-02	2.8E+00					6.2E-02	6.2E+00				
Methylcholanthrene, 3-	4.1E-05	4.1E-03			4.1E+02	5.4E+01	9.3E-05	9.3E-03			7.0E+02	9.0E+01
Methylene bromide (dibromomethane)	1.2E-01	1.2E+01	1.5E+00	1.5E+02	7.9E+02	1.0E+02	2.7E-01	2.7E+01	4.4E+00	4.4E+02	1.1E+03	1.4E+02
Methylene chloride (dichloromethane)					1.3E+03	1.6E+02					2.1E+03	2.8E+02
Methylene-bis (2-chloroaniline) 4,4'-	9.1E-03	9.1E-01	4.9E-02	4.9E+00	2.0E+04	2.6E+03	2.0E-02	2.0E+00	1.5E-01	1.5E+01	3.3E+04	4.3E+03
Methylmercury hydroxide			2.4E-03	2.4E-01	1.5E+02	2.0E+01			7.3E-03	7.3E-01	2.0E+02	2.9E+01
Methylnaphthalene, 1-	3.1E-02	3.1E+00	1.7E+00	1.7E+02			7.0E-02	7.0E+00	5.1E+00	5.1E+02		
Methylnaphthalene, 2-			9.8E-02	9.8E+00					2.9E-01	2.9E+01		
Methylpyrrolidone, N-			4.9E-01	4.9E+01	1.8E+06	2.3E+05			1.5E+00	1.5E+02	2.5E+06	3.3E+05
Methyltetrahydrofuran, 2-	1.2E-01	1.2E+01	4.9E+00	4.9E+02	1.8E+03	2.3E+02	2.7E-01	2.7E+01	1.5E+01	1.5E+03	3.1E+03	3.9E+02
Methyltetrahydropyran, 2-	1.2E-01	1.2E+01	4.9E+00	4.9E+02	2.1E+03	2.7E+02	2.7E-01	2.7E+01	1.5E+01	1.5E+03	3.6E+03	4.6E+02
Metolachlor			3.7E+00	3.7E+02					1.1E+01	1.1E+03		
Metribuzin			6.1E-01	6.1E+01					1.8E+00	1.8E+02		
Mirex			4.9E-03	4.9E-01					1.5E-02	1.5E+00		
Molinate			4.9E-02	4.9E+00					1.5E-01	1.5E+01		
Molybdenum			1.2E-01	1.2E+01					3.7E-01	3.7E+01		
Monocrotophos			1.5E-02	1.5E+00	2.2E+05	2.1E+05			4.4E-02	4.4E+00	3.1E+05	3.0E+05

**Table 8**  
**Individual Tier 1 Groundwater PCLs**  
**Residential and Commercial/Industrial**

	Residential						Commercial/Industrial					
	Carcinogenic		Noncarcinogenic				Carcinogenic		Noncarcinogenic			
Chemical of Concern					Air GW <sub>Inh-V</sub> 0.5 acre source area (mg/L)	Air GW <sub>Inh-V</sub> 30 acre source area (mg/L)					Air GW <sub>Inh-V</sub> 0.5 acre source area (mg/L)	Air GW <sub>Inh-V</sub> 30 acre source area (mg/L)
	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)			GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)		
Morpholine			1.2E+04	1.2E+06	2.1E+04	2.7E+03			3.7E+04	3.7E+06	2.9E+04	3.7E+03
MTBE (methyl tert-butyl ether)	5.1E-01	5.1E+01	2.4E-01	2.4E+01	4.0E+03	5.2E+02	1.1E+00	1.1E+02	7.3E-01	7.3E+01	6.8E+03	8.8E+02
Naled			4.9E-02	4.9E+00	2.2E+03	2.8E+02			1.5E-01	1.5E+01	3.0E+03	3.9E+02
Naphthalene			4.9E-01	4.9E+01	3.2E+02	4.1E+01			1.5E+00	1.5E+02	4.4E+02	5.7E+01
Naphthoquinone, 1,4-			1.7E-01	1.7E+01	1.6E+03	2.1E+02			5.1E-01	5.1E+01	2.3E+03	2.9E+02
Naphthylamine, 1-			4.9E-01	4.9E+01					1.5E+00	1.5E+02		
Naphthylamine, 2-	5.1E-04	5.1E-02					1.1E-03	1.1E-01				
Napropamide			2.4E+00	2.4E+02					7.3E+00	7.3E+02		
Neopentyl glycol			7.3E+00	7.3E+02					2.2E+01	2.2E+03		
Nickel and compounds			4.9E-01	4.9E+01					1.5E+00	1.5E+02		
Nitrate												
Nitrite												
Nitroaniline, 2-			7.3E-03	7.3E-01	4.0E+03	5.2E+02			2.2E-02	2.2E+00	5.6E+03	7.2E+02
Nitroaniline, 3-	2.4E-02	2.4E+00	7.3E-03	7.3E-01	7.1E+04	9.2E+03	5.4E-02	5.4E+00	2.2E-02	2.2E+00	1.0E+05	1.3E+04
Nitroaniline, 4-	4.6E-02	4.6E+00	9.8E-02	9.8E+00	1.4E+05	1.9E+04	1.0E-01	1.0E+01	2.9E-01	2.9E+01	2.0E+05	2.6E+04
Nitrobenzene			4.9E-02	4.9E+00	7.2E+02	9.3E+01			1.5E-01	1.5E+01	1.2E+03	1.6E+02
Nitroglycerin	5.4E-02	5.4E+00	2.4E-03	2.4E-01			1.2E-01	1.2E+01	7.3E-03	7.3E-01		
Nitrophenol, 2-			4.9E-02	4.9E+00	6.7E+04	8.7E+03			1.5E-01	1.5E+01	9.4E+04	1.2E+04
Nitrophenol, 3-			4.9E-02	4.9E+00	3.1E+05	2.3E+05			1.5E-01	1.5E+01	4.4E+05	3.2E+05
Nitrophenol, 4-			4.9E-02	4.9E+00	2.4E+04	3.1E+03			1.5E-01	1.5E+01	3.3E+04	4.3E+03
Nitropropane, 2-			3.4E-03	3.4E-01	1.7E+00	2.2E-01			1.0E-02	1.0E+00	2.9E+00	3.8E-01
Nitroquinoline-N-oxide, 4-	9.7E-05	9.7E-03			1.1E+04	1.1E+04	2.2E-04	2.2E-02			1.9E+04	1.8E+04
Nitrosodiethanolamine	3.3E-04	3.3E-02					7.3E-04	7.3E-02				
Nitrosodiethylamine, n-	6.1E-06	6.1E-04			7.4E+00	9.5E-01	1.4E-05	1.4E-03			1.2E+01	1.6E+00
Nitrosodimethylamine, n-	1.8E-05	1.8E-03	2.0E-04	2.0E-02	2.0E+01	2.6E+00	4.0E-05	4.0E-03	5.8E-04	5.8E-02	3.4E+01	4.4E+00
Nitrosodi-n-butylamine, n-	1.7E-04	1.7E-02			4.7E+00	6.1E-01	3.8E-04	3.8E-02			7.9E+00	1.0E+00
Nitrosodi-n-propylamine, n-	1.3E-04	1.3E-02					2.9E-04	2.9E-02				
Nitrosodiphenylamine	1.9E-01	1.9E+01					4.2E-01	4.2E+01				
Nitroso-methyl-ethyl-amine, n-	4.1E-05	4.1E-03					9.3E-05	9.3E-03				
Nitrosomorpholine, N-	1.4E-04	1.4E-02			2.7E+02	3.6E+01	3.1E-04	3.1E-02			4.6E+02	6.0E+01
Nitroso-n-ethylurea, n-	6.5E-06	6.5E-04					1.5E-05	1.5E-03				
Nitrosopiperidine, N-	9.7E-05	9.7E-03			1.6E+02	2.1E+01	2.2E-04	2.2E-02			2.8E+02	3.6E+01
Nitrosopyrrolidine, n-	4.3E-04	4.3E-02			9.6E+02	1.2E+02	9.7E-04	9.7E-02			1.6E+03	2.1E+02
Nitrotoluene, m-			2.4E-01	2.4E+01	6.6E+03	8.5E+02			7.3E-01	7.3E+01	9.2E+03	1.2E+03

**Table 8**  
**Individual Tier 1 Groundwater PCLs**  
**Residential and Commercial/Industrial**

	Residential						Commercial/Industrial					
	Carcinogenic		Noncarcinogenic				Carcinogenic		Noncarcinogenic			
Chemical of Concern					Air GW <sub>Inh-V</sub> 0.5 acre source area (mg/L)	Air GW <sub>Inh-V</sub> 30 acre source area (mg/L)					Air GW <sub>Inh-V</sub> 0.5 acre source area (mg/L)	Air GW <sub>Inh-V</sub> 30 acre source area (mg/L)
	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)			GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)		
Nitrotoluene, o-	4.1E-03	4.1E-01	2.2E-02	2.2E+00	7.7E+03	1.0E+03	9.3E-03	9.3E-01	6.6E-02	6.6E+00	1.1E+04	1.4E+03
Nitrotoluene, p-	5.7E-02	5.7E+00	9.8E-02	9.8E+00	6.5E+03	8.4E+02	1.3E-01	1.3E+01	2.9E-01	2.9E+01	9.1E+03	1.2E+03
Nonachlor, cis-	2.6E-03	2.6E-01	1.2E-02	1.2E+00	7.7E+02	9.9E+01	5.8E-03	5.8E-01	3.7E-02	3.7E+00	1.3E+03	1.7E+02
Nonachlor, trans-	2.6E-03	2.6E-01	1.2E-02	1.2E+00	7.7E+02	9.9E+01	5.8E-03	5.8E-01	3.7E-02	3.7E+00	1.3E+03	1.7E+02
Nonanal			4.9E+00	4.9E+02					1.5E+01	1.5E+03		
Nonene, 1-n			2.4E+00	2.4E+02	1.1E+00	1.4E-01			7.3E+00	7.3E+02	1.5E+00	2.0E-01
Nonylphenol			2.4E+00	2.4E+02	6.8E+05	8.8E+04			7.3E+00	7.3E+02	9.5E+05	1.2E+05
Nonylphenol			2.4E+00	2.4E+02	6.8E+05	8.8E+04			7.3E+00	7.3E+02	9.5E+05	1.2E+05
Nonylphenol			2.4E+00	2.4E+02	6.8E+05	8.8E+04			7.3E+00	7.3E+02	9.5E+05	1.2E+05
Nonylphenol ethoxylate			2.4E+00	2.4E+02	1.8E+05	2.3E+04			7.3E+00	7.3E+02	2.5E+05	3.2E+04
Octamethylpyrophosphoramide			4.9E-02	4.9E+00					1.5E-01	1.5E+01		
Octanone			1.5E+00	1.5E+02	4.8E+06	6.2E+05			4.4E+00	4.4E+02	6.7E+06	8.7E+05
Oxamyl												
Oxychlorane	2.6E-03	2.6E-01	1.2E-02	1.2E+00	7.7E+02	9.9E+01	5.8E-03	5.8E-01	3.7E-02	3.7E+00	1.3E+03	1.7E+02
Paraquat			1.1E-01	1.1E+01					3.3E-01	3.3E+01		
Parathion (ethyl parathion)			1.5E-01	1.5E+01	1.5E+03	1.9E+02			4.4E-01	4.4E+01	2.1E+03	2.7E+02
Pebulate			1.2E+00	1.2E+02					3.7E+00	3.7E+02		
Pendimethalin			9.8E-01	9.8E+01					2.9E+00	2.9E+02		
Pentachlorobenzene			2.0E-02	2.0E+00	7.7E+03	1.0E+03			5.8E-02	5.8E+00	1.1E+04	1.4E+03
Pentachloroethane	1.0E-02	1.0E+00	7.3E-01	7.3E+01	3.0E+02	3.8E+01	2.3E-02	2.3E+00	2.2E+00	2.2E+02	5.0E+02	6.4E+01
Pentachloronitrobenzene	3.5E-03	3.5E-01	7.3E-02	7.3E+00	1.2E+02	1.6E+01	7.9E-03	7.9E-01	2.2E-01	2.2E+01	1.7E+02	2.2E+01
Pentachlorophenol					1.3E+04	1.7E+03					1.9E+04	2.4E+03
Pentadiene, 1,3-trans-			1.5E+00	1.5E+02	7.6E+04	9.8E+03			4.4E+00	4.4E+02	1.1E+05	1.4E+04
Pentaerythritol tetranitrate (PETN)			9.8E+00	9.8E+02					2.9E+01	2.9E+03		
Pentane			1.7E+01	1.7E+03	1.4E+01	1.8E+00			5.1E+01	5.1E+03	2.0E+01	2.6E+00
Pentane, 2-methyl-			1.5E+00	1.5E+02	1.7E+03	2.3E+02			4.4E+00	4.4E+02	2.4E+03	3.2E+02
Pentane, 3-methyl-			1.5E+00	1.5E+02	2.2E+03	2.9E+02			4.4E+00	4.4E+02	3.1E+03	4.0E+02
Pentanediol, 1,5-			1.2E+02	1.2E+04	4.4E+08	5.8E+07			3.7E+02	3.7E+04	6.2E+08	8.1E+07
Pentanol, 1-			8.1E-01	8.1E+01	1.6E+06	2.1E+05			2.4E+00	2.4E+02	2.2E+06	2.9E+05
Pentanol, 4-methyl-2-			6.4E-01	6.4E+01	1.3E+05	1.7E+04			1.9E+00	1.9E+02	1.8E+05	2.4E+04
Pentanone, 2-			9.8E-01	9.8E+01	2.2E+05	2.9E+04			2.9E+00	2.9E+02	3.1E+05	4.0E+04
Pentyne, 1-			1.5E+00	1.5E+02	7.2E+04	9.3E+03			4.4E+00	4.4E+02	1.0E+05	1.3E+04
Perchlorate			1.7E-02	1.7E+00					5.1E-02	5.1E+00		
Perylene			4.9E-01	4.9E+01					1.5E+00	1.5E+02		

Table 8  
Individual Tier 1 Groundwater PCLs  
Residential and Commercial/Industrial

	Residential						Commercial/Industrial					
	Carcinogenic		Noncarcinogenic				Carcinogenic		Noncarcinogenic			
Chemical of Concern					Air GW <sub>Inh-V</sub> 0.5 acre source area (mg/L)	Air GW <sub>Inh-V</sub> 30 acre source area (mg/L)					Air GW <sub>Inh-V</sub> 0.5 acre source area (mg/L)	Air GW <sub>Inh-V</sub> 30 acre source area (mg/L)
	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)			GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)		
Phenacetin	4.1E-01	4.1E+01			1.1E+06	1.5E+05	9.3E-01	9.3E+01			1.9E+06	2.5E+05
Phenanthrene			7.3E-01	7.3E+01					2.2E+00	2.2E+02		
Phenanthridine			7.3E-02	7.3E+00					2.2E-01	2.2E+01		
Phenol			7.3E+00	7.3E+02	2.8E+05	3.6E+04			2.2E+01	2.2E+03	3.9E+05	5.0E+04
Phenol, 4-tert-butyl-			1.2E-01	1.2E+01	1.3E+05	1.7E+04			3.7E-01	3.7E+01	1.8E+05	2.3E+04
Phenothiazine			2.7E-02	2.7E+00	1.6E+05	2.0E+04			8.0E-02	8.0E+00	2.2E+05	2.8E+04
Phenyl mercuric acetate			2.0E-03	2.0E-01					5.8E-03	5.8E-01		
Phenylene diamine, m-			1.5E-01	1.5E+01	2.0E+03	2.6E+02			4.4E-01	4.4E+01	2.8E+03	3.7E+02
Phenylene diamine, p-			4.6E+00	4.6E+02	2.3E+03	3.0E+02			1.4E+01	1.4E+03	3.2E+03	4.2E+02
Phorate			4.9E-03	4.9E-01	9.8E+01	1.3E+01			1.5E-02	1.5E+00	1.4E+02	1.8E+01
Phosalone			4.9E-02	4.9E+00					1.5E-01	1.5E+01		
Phosdrin (mevinphos)			6.1E-04	6.1E-02					1.8E-03	1.8E-01		
Phosmet			4.9E-01	4.9E+01	7.6E+04	9.9E+03			1.5E+00	1.5E+02	1.1E+05	1.4E+04
Phosphine			7.3E-03	7.3E-01	2.9E-03	3.7E-04			2.2E-02	2.2E+00	4.0E-03	5.2E-04
Phosphorotriothioic acid, S,S,S-tributyl ester	1.1E-02	1.1E+00	2.4E-02	2.4E+00			2.4E-02	2.4E+00	7.3E-02	7.3E+00		
Phosphorus, total*												
Phosphorus, white			4.9E-04	4.9E-02					1.5E-03	1.5E-01		
Phthalic anhydride			4.9E+01	4.9E+03	3.1E+06	4.0E+05			1.5E+02	1.5E+04	4.3E+06	5.6E+05
Picloram												
Picoline, 2- (2-methylpyridine)			2.2E-01	2.2E+01	4.9E+02	6.3E+01			6.6E-01	6.6E+01	6.8E+02	8.8E+01
Polybrominated biphenyls (PBBs)	1.0E-04	1.0E-02	1.7E-04	1.7E-02			2.3E-04	2.3E-02	5.1E-04	5.1E-02		
Polychlorinated biphenyls (PCBs)					2.9E+00	3.8E-01					4.9E+00	6.4E-01
Potassium*												
Primene			1.5E-01	1.5E+01	8.5E+02	1.1E+02			4.4E-01	4.4E+01	1.2E+03	1.5E+02
Prometon (pramitol)			3.7E-01	3.7E+01					1.1E+00	1.1E+02		
Pronamide			1.8E+00	1.8E+02					5.5E+00	5.5E+02		
Propanal (propionaldehyde)			2.0E-01	2.0E+01	1.6E+03	2.1E+02			5.8E-01	5.8E+01	2.3E+03	3.0E+02
Propane, 1-bromo-			8.8E-01	8.8E+01	1.1E+03	1.5E+02			2.6E+00	2.6E+02	1.6E+03	2.1E+02
Propanil			1.2E-01	1.2E+01					3.7E-01	3.7E+01		
Propanoic acid (propionic acid)			1.2E+01	1.2E+03	1.5E+04	1.9E+03			3.7E+01	3.7E+03	2.1E+04	2.7E+03
Propanol, 1-			4.9E+00	4.9E+02	8.5E+05	1.1E+05			1.5E+01	1.5E+03	1.2E+06	1.5E+05
Propargite			4.9E-01	4.9E+01					1.5E+00	1.5E+02		
Propargyl alcohol			4.9E-02	4.9E+00	3.0E+04	3.8E+03			1.5E-01	1.5E+01	4.2E+04	5.4E+03
Propazine	2.1E-02	2.1E+00	4.9E-01	4.9E+01			4.6E-02	4.6E+00	1.5E+00	1.5E+02		

**Table 8**  
**Individual Tier 1 Groundwater PCLs**  
**Residential and Commercial/Industrial**

	Residential						Commercial/Industrial					
	Carcinogenic		Noncarcinogenic				Carcinogenic		Noncarcinogenic			
Chemical of Concern					Air GW <sub>Inh-V</sub> 0.5 acre source area	Air GW <sub>Inh-V</sub> 30 acre source area					Air GW <sub>Inh-V</sub> 0.5 acre source area	Air GW <sub>Inh-V</sub> 30 acre source area
	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	(mg/L)	(mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	(mg/L)	(mg/L)
Propam			4.9E-01	4.9E+01					1.5E+00	1.5E+02		
Propionitrile (propane nitrile)			9.8E-03	9.8E-01	7.7E+03	9.9E+02			2.9E-02	2.9E+00	1.1E+04	1.4E+03
Propyl acetate, n-			2.2E+00	2.2E+02					6.6E+00	6.6E+02		
Propylbenzene, n-			9.8E-01	9.8E+01	6.0E+03	7.8E+02			2.9E+00	2.9E+02	8.5E+03	1.1E+03
Propylene glycol			4.9E+02	4.9E+04	2.6E+06	3.4E+05			1.5E+03	1.5E+05	3.7E+06	4.8E+05
Propylene glycol monomethyl ether			1.7E+01	1.7E+03	2.9E+07	3.7E+06			5.1E+01	5.1E+03	4.0E+07	5.2E+06
Propylene oxide	3.8E-03	3.8E-01			1.6E+03	2.0E+02	8.5E-03	8.5E-01			2.7E+03	3.4E+02
Propylene tetramer			2.4E+00	2.4E+02	4.4E+01	5.7E+00			7.3E+00	7.3E+02	6.2E+01	8.0E+00
Prothiofos (Tokuthion)			2.4E-03	2.4E-01	1.4E+03	1.8E+02			7.3E-03	7.3E-01	2.0E+03	2.5E+02
Pyrene			7.3E-01	7.3E+01					2.2E+00	2.2E+02		
Pyridine			2.4E-02	2.4E+00	2.2E+02	2.9E+01			7.3E-02	7.3E+00	3.1E+02	4.0E+01
Quinoline	3.0E-04	3.0E-02			4.3E+03	5.6E+02	6.8E-04	6.8E-02			6.0E+03	7.8E+02
Ronnel			1.2E+00	1.2E+02					3.7E+00	3.7E+02		
Safrole	4.1E-03	4.1E-01			1.9E+02	2.4E+01	9.3E-03	9.3E-01			3.2E+02	4.1E+01
Selenium												
Selenourea			1.2E-01	1.2E+01					3.7E-01	3.7E+01		
Silver			1.2E-01	1.2E+01					3.7E-01	3.7E+01		
Simazine												
Sodium*												
Sodium diethyldithiocarbamate	3.4E-03	3.4E-01	7.3E-01	7.3E+01			7.6E-03	7.6E-01	2.2E+00	2.2E+02		
Sodium hypochlorite			5.1E+00	5.1E+02					1.5E+01	1.5E+03		
Sodium polyacrylate			1.2E+01	1.2E+03	1.5E+04	2.0E+03			3.7E+01	3.7E+03	2.1E+04	2.7E+03
Strontium			1.5E+01	1.5E+03					4.4E+01	4.4E+03		
Strychnine			7.3E-03	7.3E-01					2.2E-02	2.2E+00		
Styrene					1.5E+04	2.0E+03					2.1E+04	2.7E+03
Sulfate*												
Sulfide*												
Sulfolane			4.9E-04	4.9E-02					1.5E-03	1.5E-01		
Sulfur*												
Sulprofos (Bolstar)			7.3E-02	7.3E+00	2.7E+04	3.4E+03			2.2E-01	2.2E+01	3.7E+04	4.8E+03
TCDD, 2,3,7,8- (dioxin)												
Tebuconazole			7.3E-01	7.3E+01					2.2E+00	2.2E+02		
Tebuthiuron			1.7E+00	1.7E+02					5.1E+00	5.1E+02		
Terbufos			6.1E-04	6.1E-02					1.8E-03	1.8E-01		

**Table 8**  
**Individual Tier 1 Groundwater PCLs**  
**Residential and Commercial/Industrial**

	Residential						Commercial/Industrial					
	Carcinogenic		Noncarcinogenic				Carcinogenic		Noncarcinogenic			
Chemical of Concern					Air GW <sub>Inh-V</sub> 0.5 acre source area	Air GW <sub>Inh-V</sub> 30 acre source area					Air GW <sub>Inh-V</sub> 0.5 acre source area	Air GW <sub>Inh-V</sub> 30 acre source area
	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)			GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)		
Tert-amyl ethyl ether (TAEE)			9.8E-01	9.8E+01	1.5E+03	1.9E+02			2.9E+00	2.9E+02	2.1E+03	2.7E+02
Tert-amyl-methyl ether (TAME)			9.8E-01	9.8E+01	2.5E+03	3.2E+02			2.9E+00	2.9E+02	3.5E+03	4.5E+02
Tert-butyl alcohol (2-methyl-2-propanol)			2.2E+00	2.2E+02	5.1E+05	6.6E+04			6.6E+00	6.6E+02	7.1E+05	9.2E+04
Tetrachlorobenzene, 1,2,3,4-			7.3E-03	7.3E-01	2.9E+04	3.7E+03			2.2E-02	2.2E+00	4.1E+04	5.2E+03
Tetrachlorobenzene, 1,2,3,5-			7.3E-03	7.3E-01	3.3E+04	4.3E+03			2.2E-02	2.2E+00	4.7E+04	6.1E+03
Tetrachlorobenzene, 1,2,4,5-			7.3E-03	7.3E-01	3.8E+04	5.0E+03			2.2E-02	2.2E+00	5.4E+04	6.9E+03
Tetrachloroethane, 1,1,1,2-	3.5E-02	3.5E+00	7.3E-01	7.3E+01	1.1E+02	1.4E+01	7.9E-02	7.9E+00	2.2E+00	2.2E+02	1.9E+02	2.4E+01
Tetrachloroethane, 1,1,2,2-	4.6E-03	4.6E-01	9.8E-02	9.8E+00	4.4E+01	5.7E+00	1.0E-02	1.0E+00	2.9E-01	2.9E+01	7.4E+01	9.6E+00
Tetrachloroethylene					5.0E+02	6.4E+01					8.4E+02	1.1E+02
Tetrachlorophenol, 2,3,4,5-			7.3E-01	7.3E+01	1.9E+05	2.4E+04			2.2E+00	2.2E+02	2.6E+05	3.4E+04
Tetrachlorophenol, 2,3,4,6-			7.3E-01	7.3E+01	6.9E+04	9.0E+03			2.2E+00	2.2E+02	9.7E+04	1.3E+04
Tetrachlorophenol, 2,3,5,6-			7.3E-01	7.3E+01	2.0E+03	2.6E+02			2.2E+00	2.2E+02	2.8E+03	3.7E+02
Tetrachlorvinphos (Stiropfos)			1.0E+00	1.0E+02	4.2E+05	5.5E+04			3.1E+00	3.1E+02	5.9E+05	7.7E+04
Tetradifon			4.9E-01	4.9E+01					1.5E+00	1.5E+02		
Tetraethyl dithiopyrophosphate (sulfotep)			1.2E-02	1.2E+00	3.4E+03	4.4E+02			3.7E-02	3.7E+00	4.8E+03	6.2E+02
Tetraethyl lead			2.4E-06	2.4E-04	7.7E-01	9.9E-02			7.3E-06	7.3E-04	1.1E+00	1.4E-01
Tetraethyl pyrophosphate (TEPP)			2.7E-04	2.7E-02	2.2E+03	2.8E+02			8.0E-04	8.0E-02	3.0E+03	3.9E+02
Tetraethylene glycol			8.1E+00	8.1E+02	2.2E+06	1.9E+06			2.4E+01	2.4E+03	3.1E+06	2.6E+06
Tetrahydrofuran	1.2E-01	1.2E+01	4.9E+00	4.9E+02	2.2E+03	2.9E+02	2.7E-01	2.7E+01	1.5E+01	1.5E+03	3.7E+03	4.8E+02
Tetrahydropyran	1.2E-01	1.2E+01	4.9E+00	4.9E+02	2.6E+03	3.4E+02	2.7E-01	2.7E+01	1.5E+01	1.5E+03	4.4E+03	5.7E+02
Tetraoxadodecane, 2,5,8,11-			6.1E-01	6.1E+01	1.1E+06	1.4E+05			1.8E+00	1.8E+02	1.5E+06	2.0E+05
Thallium and compounds (as thallium chloride)												
Thiofanox			7.3E-03	7.3E-01	2.5E+04	3.2E+03			2.2E-02	2.2E+00	3.4E+04	4.5E+03
Thionazin			1.7E-03	1.7E-01					5.1E-03	5.1E-01		
Thiophanate-methyl			2.0E+00	2.0E+02					5.8E+00	5.8E+02		
Thiram			1.2E-01	1.2E+01	3.2E+04	4.1E+03			3.7E-01	3.7E+01	4.5E+04	5.8E+03
Tin			1.5E+01	1.5E+03					4.4E+01	4.4E+03		
Titanium			1.2E+02	1.2E+04					3.7E+02	3.7E+04		
Toluene					6.4E+04	8.2E+03					8.9E+04	1.2E+04
Toluene diisocyanate, 2,4/2,6-					1.8E+03	2.4E+02					2.6E+03	3.3E+02
Toluenediamine, 2,4-	2.9E-04	2.9E-02			1.3E+05	1.7E+04	6.4E-04	6.4E-02			1.8E+05	2.3E+04
Toluenediamine, 2,6-			7.3E-01	7.3E+01					2.2E+00	2.2E+02		
Toluidine, o-	3.8E-03	3.8E-01			2.6E+03	3.4E+02	8.5E-03	8.5E-01			4.4E+03	5.7E+02
Toluidine, p-	4.8E-03	4.8E-01					1.1E-02	1.1E+00				

**Table 8**  
**Individual Tier 1 Groundwater PCLs**  
**Residential and Commercial/Industrial**

	Residential						Commercial/Industrial					
	Carcinogenic		Noncarcinogenic				Carcinogenic		Noncarcinogenic			
Chemical of Concern					Air GW <sub>Inh-V</sub> 0.5 acre source area (mg/L)	Air GW <sub>Inh-V</sub> 30 acre source area (mg/L)					Air GW <sub>Inh-V</sub> 0.5 acre source area (mg/L)	Air GW <sub>Inh-V</sub> 30 acre source area (mg/L)
	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)			GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)		
Toxaphene					1.8E+03	2.3E+02					3.0E+03	3.9E+02
TPH, TX1005, C6-C12			9.8E-01	9.8E+01	1.8E+03	2.3E+02			2.9E+00	2.9E+02	2.5E+03	3.2E+02
TPH, TX1005, >C12-C28			9.8E-01	9.8E+01	7.5E+03	9.7E+02			2.9E+00	2.9E+02	1.0E+04	1.4E+03
TPH, TX1005, >C12-C35			9.8E-01	9.8E+01	7.5E+03	9.7E+02			2.9E+00	2.9E+02	1.0E+04	1.4E+03
TPH, TX1005, >C28-C35			9.8E-01	9.8E+01	7.5E+03	9.7E+02			2.9E+00	2.9E+02	1.0E+04	1.4E+03
TP Silvex, 2,4,5-					3.5E+05	4.5E+04					4.9E+05	6.4E+04
Triademenol			7.3E-01	7.3E+01					2.2E+00	2.2E+02		
Triallate			3.2E-01	3.2E+01					9.5E-01	9.5E+01		
Triaminotrinitrobenzene (TATB)	3.0E-02	3.0E+00	7.3E-02	7.3E+00	4.2E+05	3.7E+05	6.8E-02	6.8E+00	2.2E-01	2.2E+01	5.9E+05	5.1E+05
Tributyltin oxide			7.3E-03	7.3E-01					2.2E-02	2.2E+00		
Trichloro-1,2,2-trifluoroethane, 1,1,2-			7.3E+02	7.3E+04	9.2E+03	1.2E+03			2.2E+03	2.2E+05	1.3E+04	1.7E+03
Trichlorobenzene, 1,2,3-			7.3E-02	7.3E+00	2.7E+03	3.5E+02			2.2E-01	2.2E+01	3.7E+03	4.8E+02
Trichlorobenzene, 1,2,4-					1.6E+02	2.0E+01					2.2E+02	2.8E+01
Trichlorobenzene, 1,3,5-			7.3E-02	7.3E+00	2.0E+03	2.6E+02			2.2E-01	2.2E+01	2.9E+03	3.7E+02
Trichloroethane, 1,1,1-					4.0E+04	5.1E+03					5.6E+04	7.2E+03
Trichloroethane, 1,1,2-					8.0E+01	1.0E+01					1.3E+02	1.7E+01
Trichloroethylene					1.2E+02	1.5E+01					1.7E+02	2.1E+01
Trichlorofluoromethane			7.3E+00	7.3E+02	4.1E+03	5.3E+02			2.2E+01	2.2E+03	5.7E+03	7.4E+02
Trichloronate			7.3E-02	7.3E+00					2.2E-01	2.2E+01		
Trichlorophenol, 2,3,4-			2.4E+00	2.4E+02	1.1E+06	1.4E+05			7.3E+00	7.3E+02	1.5E+06	1.9E+05
Trichlorophenol, 2,3,5-			2.4E+00	2.4E+02	1.1E+06	1.4E+05			7.3E+00	7.3E+02	1.5E+06	2.0E+05
Trichlorophenol, 2,3,6-			2.4E+00	2.4E+02	8.4E+03	1.1E+03			7.3E+00	7.3E+02	1.2E+04	1.5E+03
Trichlorophenol, 2,4,5-			2.4E+00	2.4E+02	4.5E+05	5.9E+04			7.3E+00	7.3E+02	6.4E+05	8.2E+04
Trichlorophenol, 2,4,6-	8.3E-02	8.3E+00	2.4E-02	2.4E+00	4.9E+04	6.4E+03	1.9E-01	1.9E+01	7.3E-02	7.3E+00	8.3E+04	1.1E+04
Trichlorophenol, 3,4,5-			2.4E+00	2.4E+02	1.1E+06	1.5E+05			7.3E+00	7.3E+02	1.6E+06	2.1E+05
Trichlorophenoxyacetic acid, 2,4,5-			2.4E-01	2.4E+01	2.5E+05	3.3E+04			7.3E-01	7.3E+01	3.5E+05	4.6E+04
Trichloropropane, 1,1,2-			1.2E-01	1.2E+01	5.4E+02	6.9E+01			3.7E-01	3.7E+01	7.5E+02	9.7E+01
Trichloropropane, 1,2,3-	3.0E-05	3.0E-03	9.8E-02	9.8E+00	4.3E+02	5.6E+01	6.8E-05	6.8E-03	2.9E-01	2.9E+01	6.0E+02	7.8E+01
Triethanolamine			4.9E+00	4.9E+02	1.5E+07	1.5E+07			1.5E+01	1.5E+03	2.1E+07	2.1E+07
Triethylamine					6.3E+02	8.1E+01					8.8E+02	1.1E+02
Triethylene glycol			7.3E+01	7.3E+03					2.2E+02	2.2E+04		
Triethylphosphorothioate, O, O, O-			2.0E-04	2.0E-02					6.1E-04	6.1E-02		
Trifluralin	1.2E-01	1.2E+01	1.8E-01	1.8E+01	2.7E+04	3.4E+03	2.7E-01	2.7E+01	5.5E-01	5.5E+01	3.7E+04	4.8E+03
Trimethylamine					1.7E+03	2.2E+02					2.3E+03	3.0E+02

**Table 8**  
**Individual Tier 1 Groundwater PCLs**  
**Residential and Commercial/Industrial**

	Residential						Commercial/Industrial					
	Carcinogenic		Noncarcinogenic				Carcinogenic		Noncarcinogenic			
Chemical of Concern					Air GW <sub>Inh-V</sub> 0.5 acre source area (mg/L)	Air GW <sub>Inh-V</sub> 30 acre source area (mg/L)					Air GW <sub>Inh-V</sub> 0.5 acre source area (mg/L)	Air GW <sub>Inh-V</sub> 30 acre source area (mg/L)
	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)			GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)		
Trimethylbenzene, 1,2,3-			1.2E+00	1.2E+02	1.9E+02	2.4E+01			3.7E+00	3.7E+02	2.6E+02	3.4E+01
Trimethylbenzene, 1,2,4-			2.4E-01	2.4E+01	1.9E+02	2.5E+01			7.3E-01	7.3E+01	2.7E+02	3.4E+01
Trimethylbenzene, 1,3,5-			1.2E+00	1.2E+02	1.3E+02	1.6E+01			3.7E+00	3.7E+02	1.8E+02	2.3E+01
Trinitrobenzene, 1,3,5-			7.3E-01	7.3E+01					2.2E+00	2.2E+02		
Trinitrophenylmethylnitramine (tetryl; nitramine)			9.8E-02	9.8E+00	4.4E+03	1.7E+03			2.9E-01	2.9E+01	6.2E+03	2.3E+03
Trinitrotoluene, 2,4,6-	3.0E-02	3.0E+00	1.2E-02	1.2E+00	2.2E+03	2.9E+02	6.8E-02	6.8E+00	3.7E-02	3.7E+00	3.1E+03	4.1E+02
Uranium (soluble salts)												
Valeric acid (pentanoic acid)			1.2E+01	1.2E+03	2.0E+04	2.6E+03			3.7E+01	3.7E+03	2.8E+04	3.6E+03
Vanadium			1.7E-03	1.7E-01					5.1E-03	5.1E-01		
Vernam			2.4E-02	2.4E+00					7.3E-02	7.3E+00		
Vinyl acetate			2.4E+01	2.4E+03	1.4E+04	1.8E+03			7.3E+01	7.3E+03	2.0E+04	2.6E+03
Vinyl chloride					3.8E+00	4.9E-01					6.4E+00	8.3E-01
Vinylcyclohexane			1.2E+01	1.2E+03	2.2E+01	2.8E+00			3.7E+01	3.7E+03	3.1E+01	4.0E+00
Warfarin			7.3E-03	7.3E-01	4.6E+03	6.0E+02			2.2E-02	2.2E+00	6.5E+03	8.4E+02
Xylene, m-					1.1E+04	1.4E+03					1.5E+04	1.9E+03
Xylene, o-					7.6E+05	9.8E+04					1.1E+06	1.4E+05
Xylene, p-					9.4E+03	1.2E+03					1.3E+04	1.7E+03
Xylenes					1.0E+04	1.3E+03					1.4E+04	1.9E+03
Zinc			7.3E+00	7.3E+02					2.2E+01	2.2E+03		
6 C aliphatics (TPH)	---	---	1.5E+00	1.5E+02	3.2E+01	4.1E+00	---	---	4.4E+00	4.4E+02	4.5E+01	5.8E+00
>6-8 C aliphatics (TPH)	---	---	1.5E+00	1.5E+02	2.1E+01	2.7E+00	---	---	4.4E+00	4.4E+02	3.0E+01	3.8E+00
>8-10 C aliphatics (TPH)	---	---	2.4E+00	2.4E+02	1.3E+01	1.7E+00	---	---	7.3E+00	7.3E+02	1.8E+01	2.4E+00
>10-12 C aliphatics (TPH)	---	---	2.4E+00	2.4E+02	8.8E+00	1.1E+00	---	---	7.3E+00	7.3E+02	1.2E+01	1.6E+00
>12-16 C aliphatics (TPH)	---	---	2.4E+00	2.4E+02	2.0E+00	2.6E-01	---	---	7.3E+00	7.3E+02	2.8E+00	3.7E-01
>16-21 C aliphatics (TPH)	---	---	4.9E+01	4.9E+03	---	---	---	---	1.5E+02	1.5E+04	---	---
>16-21 C, >21-35 C aliphatics (TPH) (for transformer m	---	---	3.9E+01	3.9E+03	---	---	---	---	1.2E+02	1.2E+04	---	---
>7-8 C aromatics (TPH)	---	---	2.4E+00	2.4E+02	1.6E+04	2.0E+03	---	---	7.3E+00	7.3E+02	2.2E+04	2.8E+03
>8-10 C aromatics (TPH)	---	---	9.8E-01	9.8E+01	1.8E+03	2.3E+02	---	---	2.9E+00	2.9E+02	2.5E+03	3.2E+02
>10-12 C aromatics (TPH)	---	---	9.8E-01	9.8E+01	4.3E+03	5.5E+02	---	---	2.9E+00	2.9E+02	6.0E+3	7.7E+02
>12-16 C aromatics (TPH)	---	---	9.8E-01	9.8E+01	7.5E+03	9.7E+02	---	---	2.9E+00	2.9E+02	1.0E+04	1.4E+03
>16-21 C aromatics (TPH)	---	---	7.3E-01	7.3E+01	---	---	---	---	2.2E+00	2.2E+02	---	---
>21-35 C aromatics (TPH)	---	---	7.3E-01	7.3E+01	---	---	---	---	2.2E+00	2.2E+02	---	---
Footnotes												
<sup>1</sup> Based on primary MCLs when available												

**Table 8**  
**Individual Tier 1 Groundwater PCLs**  
**Residential and Commercial/Industrial**

	Residential						Commercial/Industrial					
	Carcinogenic		Noncarcinogenic				Carcinogenic		Noncarcinogenic			
Chemical of Concern					Air GW <sub>Inh-V</sub> 0.5 acre source area	Air GW <sub>Inh-V</sub> 30 acre source area					Air GW <sub>Inh-V</sub> 0.5 acre source area	Air GW <sub>Inh-V</sub> 30 acre source area
	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	(mg/L)	(mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	GW <sub>Ing</sub> <sup>1</sup> (mg/L)	GW <sub>Class 3</sub> <sup>2</sup> (mg/L)	(mg/L)	(mg/L)
<sup>2</sup> 100 x GWGW <sub>Ing</sub>												
<sup>3</sup> The MCL for total trihalomethanes (bromodichloromethane, bromoform, chloroform, and dibromochloromethane) is 0.08 mg/L.												
*These compounds are not necessarily of concern from a human health standpoint, therefore calculation of human health-based values is not required. However, aesthetics and ecological criteria would still apply. See table entitled "Compounds for which Calculation of a Human Health PCL is Not Required" available on the TCEQ website at <a href="http://www.tceq.state.tx.us/remediation/trrp/trrp.html">http://www.tceq.state.tx.us/remediation/trrp/trrp.html</a> .												
All values capped at 1E+06												

NATIONAL PRIMARY AND SECONDARY DRINKING WATER STANDARDS  
AND MAXIMUM CONTAMINANT LEVEL GOALS



## Drinking Water Contaminants

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# Drinking Water Contaminants

## National Primary Drinking Water Regulations

National Primary Drinking Water Regulations (NPDWRs or primary standards) are legally enforceable standards that apply to public water systems. Primary standards protect public health by limiting the levels of contaminants in drinking water. Visit the list of regulated contaminants with links for more details.

- [List of Contaminants & their Maximum Contaminant Level \(MCLs\)](#)
- [Regulation Development](#)
- [EPA's Regulated Contaminant Timeline \(PDF\)](#) (1 pp, 86 K ) ([About PDF](#))
- [National Primary Drinking Water Regulations](#)- The complete regulations regarding these contaminants available from the Code of Federal Regulations Website

## List of Contaminants & their MCLs

[An alphabetical listing with links to fact sheets on the primary drinking water regulations.](#)

- [Microorganisms](#)
- [Disinfectants](#)
- [Disinfection Byproducts](#)
- [Inorganic Chemicals](#)
- [Organic Chemicals](#)
- [Radionuclides](#)



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- [National Primary DW Regulations](#)
- [List of DW Contaminants & MCLs](#)
- [National Secondary DW Regs](#)
- [List of Secondary DW Regulations](#)
- [Unregulated Contaminants](#)

### Information on this section

- [Alphabetical List \(PDF\)](#) (6 pp, 924 K) ([About PDF](#)) EPA 816-F-09-0004, May 2009

### Microorganisms

Contaminant	MCLG <sup>1</sup> (mg/L) <sub>2</sub>	MCL or TT <sup>1</sup> (mg/L) <sub>2</sub>	Potential Health Effects from Long-Term Exposure Above the MCL (unless specified as short-term)	Sources of Contaminant in Drinking Water
<a href="#">Cryptosporidium</a>	zero	TT <sub>3</sub>	Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)	Human and animal fecal waste
<a href="#">Giardia lamblia</a>	zero	TT <sub>3</sub>	Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)	Human and animal fecal waste
<a href="#">Heterotrophic plate count</a>	n/a	TT <sub>3</sub>	HPC has no health effects; it is an analytic method used to measure the variety of bacteria that are common in	HPC measures a range of bacteria that are naturally present in the environment

Contaminant	MCLG <sup>1</sup> (mg/L) <sub>2</sub>	MCL or TT <sup>1</sup> (mg/L) <sub>2</sub>	Potential Health Effects from Long-Term Exposure Above the MCL (unless specified as short-term)	Sources of Contaminant in Drinking Water
<a href="#">Legionella</a>	zero	TT <sub>3</sub>	water. The lower the concentration of bacteria in drinking water, the better maintained the water system is.  Legionnaire's Disease, a type of pneumonia	Found naturally in water; multiplies in heating systems
<a href="#">Total Coliforms (including fecal coliform and <i>E. Coli</i>)</a>	zero	5.0% <sub>4</sub>	Not a health threat in itself; it is used to indicate whether other potentially harmful bacteria may be present <sup>5</sup>	Coliforms are naturally present in the environment; as well as feces; fecal coliforms and <i>E. coli</i> only come from human and animal fecal waste.
<a href="#">Turbidity</a>	n/a	TT <sub>3</sub>	Turbidity is a measure of the cloudiness of water. It is used to indicate water quality and filtration effectiveness (e.g., whether disease-causing organisms are present). Higher turbidity levels are often associated with higher levels of disease-causing microorganisms such as viruses, parasites and some bacteria. These organisms can cause symptoms such as nausea, cramps, diarrhea, and associated headaches.	Soil runoff
<a href="#">Viruses (enteric)</a>	zero	TT <sub>3</sub>	Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)	Human and animal fecal waste

#### Disinfection Byproducts

Contaminant	MCLG <sup>1</sup> (mg/L) <sub>2</sub>	MCL or TT <sup>1</sup> (mg/L) <sub>2</sub>	Potential Health Effects from Long-Term Exposure Above the MCL (unless specified as short-term)	Sources of Contaminant in Drinking Water
<a href="#">Bromate</a>	zero	0.010	Increased risk of cancer	Byproduct of drinking water disinfection
<a href="#">Chlorite</a>	0.8	1.0	Anemia; infants & young children: nervous system effects	Byproduct of drinking water disinfection
<a href="#">Haloacetic acids (HAA5)</a>	n/a <sub>6</sub>	0.060 <sub>7</sub>	Increased risk of cancer	Byproduct of drinking water disinfection
<a href="#">Total Trihalomethanes (TTHMs)</a>	--> n/a <sub>6</sub>	--> 0.080 <sub>7</sub>	Liver, kidney or central nervous system problems; increased risk of cancer	Byproduct of drinking water disinfection

#### Disinfectants

Contaminant	MCLG (mg/L) <sub>2</sub> <sup>1</sup>	MCL or TT (mg/L) <sub>2</sub> <sup>1</sup>	Potential Health Effects from Long-Term Exposure Above the MCL (unless specified as short-term)	Sources of Contaminant in Drinking Water
<a href="#">Chloramines (as Cl<sub>2</sub>)</a>	MRDLG=4 <sub>1</sub>	MRDL=4.0 <sub>1</sub>	Eye/nose irritation; stomach discomfort, anemia	Water additive used to control microbes
<a href="#">Chlorine (as Cl<sub>2</sub>)</a>	MRDLG=4 <sub>1</sub>	MRDL=4.0 <sub>1</sub>	Eye/nose irritation; stomach discomfort	Water additive used to control microbes
<a href="#">Chlorine dioxide (as ClO<sub>2</sub>)</a>	MRDLG=0.8 <sub>1</sub>	MRDL=0.8 <sub>1</sub>	Anemia; infants & young children: nervous system effects	Water additive used to control microbes

## Inorganic Chemicals

Contaminant	MCLG (mg/L) <sub>2</sub> <sup>1</sup>	MCL or TT (mg/L) <sub>2</sub> <sup>1</sup>	Potential Health Effects from Long-Term Exposure Above the MCL (unless specified as short-term)	Sources of Contaminant in Drinking Water
<a href="#">Antimony</a>	0.006	0.006	Increase in blood cholesterol; decrease in blood sugar	Discharge from petroleum refineries; fire retardants; ceramics; electronics; solder
<a href="#">Arsenic</a>	0 <sub>2</sub>	0.010 as of 01/23/06	Skin damage or problems with circulatory systems, and may have increased risk of getting cancer	Erosion of natural deposits; runoff from orchards, runoff from glass & electronics production wastes
<a href="#">Asbestos (fiber &gt;10 micrometers)</a>	7 million fibers per liter	7 MFL	Increased risk of developing benign intestinal polyps	Decay of asbestos cement in water mains; erosion of natural deposits
<a href="#">Barium</a>	2	2	Increase in blood pressure	Discharge of drilling wastes; discharge from metal refineries; erosion of natural deposits
<a href="#">Beryllium</a>	0.004	0.004	Intestinal lesions	Discharge from metal refineries and coal-burning factories; discharge from electrical, aerospace, and defense industries
<a href="#">Cadmium</a>	0.005	0.005	Kidney damage	Corrosion of galvanized pipes; erosion of natural deposits; discharge from metal refineries; runoff from waste batteries and paints
<a href="#">Chromium (total)</a>	0.1	0.1	Allergic dermatitis	Discharge from steel and pulp mills; erosion of natural deposits
<a href="#">Copper</a>	1.3	TT <sub>2</sub> ; Action Level=1.3	Short term exposure: Gastrointestinal distress	Corrosion of household plumbing systems; erosion of natural deposits

Contaminant	MCLG <sup>1</sup> (mg/L) <sub>2</sub>	MCL or TT <sup>1</sup> (mg/L) <sub>2</sub>	Potential Health Effects from Long-Term Exposure Above the MCL (unless specified as short-term)	Sources of Contaminant in Drinking Water
<a href="#">Cyanide (as free cyanide)</a>	0.2	0.2	<p>Long term exposure: Liver or kidney damage</p> <p>People with Wilson's Disease should consult their personal doctor if the amount of copper in their water exceeds the action level</p> <p>Nerve damage or thyroid problems</p>	Discharge from steel/metal factories; discharge from plastic and fertilizer factories
<a href="#">Fluoride</a>	4.0	4.0	Bone disease (pain and tenderness of the bones); Children may get mottled teeth	Water additive which promotes strong teeth; erosion of natural deposits; discharge from fertilizer and aluminum factories
<a href="#">Lead</a>	zero	TT <sup>2</sup> ; Action Level=0.015	<p>Infants and children: Delays in physical or mental development; children could show slight deficits in attention span and learning abilities</p> <p>Adults: Kidney problems; high blood pressure</p>	Corrosion of household plumbing systems; erosion of natural deposits
<a href="#">Mercury (inorganic)</a>	0.002	0.002	Kidney damage	Erosion of natural deposits; discharge from refineries and factories; runoff from landfills and croplands
<a href="#">Nitrate (measured as Nitrogen)</a>	10	10	Infants below the age of six months who drink water containing nitrate in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.	Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits
<a href="#">Nitrite (measured as Nitrogen)</a>	1	1	Infants below the age of six months who drink water containing nitrite in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.	Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits
<a href="#">Selenium</a>	0.05	0.05	Hair or fingernail loss; numbness in fingers or toes; circulatory problems	Discharge from petroleum refineries; erosion of natural deposits; discharge from mines

Contaminant	MCLG <sup>1</sup> (mg/L) <sub>2</sub>	MCL or TT <sup>1</sup> (mg/L) <sub>2</sub>	Potential Health Effects from Long-Term Exposure Above the MCL (unless specified as short-term)	Sources of Contaminant in Drinking Water
<a href="#">Thallium</a>	0.0005	0.002	Hair loss; changes in blood; kidney, intestine, or liver problems	Leaching from ore-processing sites; discharge from electronics, glass, and drug factories

## Organic Chemicals

Contaminant	MCLG <sup>1</sup> (mg/L) <sub>2</sub>	MCL or TT <sup>1</sup> (mg/L) <sub>2</sub>	Potential Health Effects from Long-Term Exposure Above the MCL (unless specified as short-term)	Sources of Contaminant in Drinking Water
<a href="#">Acrylamide</a>	zero	TT <sub>8</sub>	Nervous system or blood problems; increased risk of cancer	Added to water during sewage/wastewater treatment
<a href="#">Alachlor</a>	zero	0.002	Eye, liver, kidney or spleen problems; anemia; increased risk of cancer	Runoff from herbicide used on row crops
<a href="#">Atrazine</a>	0.003	0.003	Cardiovascular system or reproductive problems	Runoff from herbicide used on row crops
<a href="#">Benzene</a>	zero	0.005	Anemia; decrease in blood platelets; increased risk of cancer	Discharge from factories; leaching from gas storage tanks and landfills
<a href="#">Benzo(a)pyrene (PAHs)</a>	zero	0.0002	Reproductive difficulties; increased risk of cancer	Leaching from linings of water storage tanks and distribution lines
<a href="#">Carbofuran</a>	0.04	0.04	Problems with blood, nervous system, or reproductive system	Leaching of soil fumigant used on rice and alfalfa
<a href="#">Carbon tetrachloride</a>	zero	0.005	Liver problems; increased risk of cancer	Discharge from chemical plants and other industrial activities
<a href="#">Chlordane</a>	zero	0.002	Liver or nervous system problems; increased risk of cancer	Residue of banned termiticide
<a href="#">Chlorobenzene</a>	0.1	0.1	Liver or kidney problems	Discharge from chemical and agricultural chemical factories
<a href="#">2,4-D</a>	0.07	0.07	Kidney, liver, or adrenal gland problems	Runoff from herbicide used on row crops

Contaminant	MCLG <sub>1</sub> (mg/L) <sub>2</sub>	MCL or TT <sub>1</sub> (mg/L) <sub>2</sub>	Potential Health Effects from Long-Term Exposure Above the MCL (unless specified as short-term)	Sources of Contaminant in Drinking Water
<a href="#">Dalapon</a>	0.2	0.2	Minor kidney changes	Runoff from herbicide used on rights of way
<a href="#">1,2-Dibromo-3-chloropropane (DBCP)</a>	zero	0.0002	Reproductive difficulties; increased risk of cancer	Runoff/leaching from soil fumigant used on soybeans, cotton, pineapples, and orchards
<a href="#">o-Dichlorobenzene</a>	0.6	0.6	Liver, kidney, or circulatory system problems	Discharge from industrial chemical factories
<a href="#">p-Dichlorobenzene</a>	0.075	0.075	Anemia; liver, kidney or spleen damage; changes in blood	Discharge from industrial chemical factories
<a href="#">1,2-Dichloroethane</a>	zero	0.005	Increased risk of cancer	Discharge from industrial chemical factories
<a href="#">1,1-Dichloroethylene</a>	0.007	0.007	Liver problems	Discharge from industrial chemical factories
<a href="#">cis-1,2-Dichloroethylene</a>	0.07	0.07	Liver problems	Discharge from industrial chemical factories
<a href="#">trans-1,2-Dichloroethylene</a>	0.1	0.1	Liver problems	Discharge from industrial chemical factories
<a href="#">Dichloromethane</a>	zero	0.005	Liver problems; increased risk of cancer	Discharge from drug and chemical factories
<a href="#">1,2-Dichloropropane</a>	zero	0.005	Increased risk of cancer	Discharge from industrial chemical factories
<a href="#">Di(2-ethylhexyl) adipate</a>	0.4	0.4	Weight loss, liver problems, or possible reproductive difficulties.	Discharge from chemical factories
<a href="#">Di(2-ethylhexyl) phthalate</a>	zero	0.006	Reproductive difficulties; liver problems; increased risk of cancer	Discharge from rubber and chemical factories
<a href="#">Dinoseb</a>	0.007	0.007	Reproductive difficulties	Runoff from herbicide used on soybeans and vegetables
<a href="#">Dioxin (2,3,7,8-TCDD)</a>	zero	0.00000003	Reproductive difficulties; increased risk of cancer	Emissions from waste incineration and other

Contaminant	MCLG <sub>1</sub> (mg/L) <sub>2</sub>	MCL or TT <sub>1</sub> (mg/L) <sub>2</sub>	Potential Health Effects from Long-Term Exposure Above the MCL (unless specified as short-term)	Sources of Contaminant in Drinking Water
<a href="#">Diquat</a>	0.02	0.02	Cataracts	combustion; discharge from chemical factories Runoff from herbicide use
<a href="#">Endothall</a>	0.1	0.1	Stomach and intestinal problems	Runoff from herbicide use
<a href="#">Endrin</a>	0.002	0.002	Liver problems	Residue of banned insecticide
<a href="#">Epichlorohydrin</a>	zero	TT <sub>8</sub>	Increased cancer risk, and over a long period of time, stomach problems	Discharge from industrial chemical factories; an impurity of some water treatment chemicals
<a href="#">Ethylbenzene</a>	0.7	0.7	Liver or kidneys problems	Discharge from petroleum refineries
<a href="#">Ethylene dibromide</a>	zero	0.00005	Problems with liver, stomach, reproductive system, or kidneys; increased risk of cancer	Discharge from petroleum refineries
<a href="#">Glyphosate</a>	0.7	0.7	Kidney problems; reproductive difficulties	Runoff from herbicide use
<a href="#">Heptachlor</a>	zero	0.0004	Liver damage; increased risk of cancer	Residue of banned termiticide
<a href="#">Heptachlor epoxide</a>	zero	0.0002	Liver damage; increased risk of cancer	Breakdown of heptachlor
<a href="#">Hexachlorobenzene</a>	zero	0.001	Liver or kidney problems; reproductive difficulties; increased risk of cancer	Discharge from metal refineries and agricultural chemical factories
<a href="#">Hexachlorocyclopentadiene</a>	0.05	0.05	Kidney or stomach problems	Discharge from chemical factories
<a href="#">Lindane</a>	0.0002	0.0002	Liver or kidney problems	Runoff/leaching from insecticide used on cattle, lumber, gardens
<a href="#">Methoxychlor</a>	0.04	0.04	Reproductive difficulties	Runoff/leaching from insecticide used on fruits, vegetables, alfalfa, livestock

Contaminant	MCLG <sub>1</sub> (mg/L) <sub>2</sub>	MCL or TT <sub>1</sub> (mg/L) <sub>2</sub>	Potential Health Effects from Long-Term Exposure Above the MCL (unless specified as short-term)	Sources of Contaminant in Drinking Water
<a href="#">Oxamyl (Vydate)</a>	0.2	0.2	Slight nervous system effects	Runoff/leaching from insecticide used on apples, potatoes, and tomatoes
<a href="#">Polychlorinated biphenyls (PCBs)</a>	zero	0.0005	Skin changes; thymus gland problems; immune deficiencies; reproductive or nervous system difficulties; increased risk of cancer	Runoff from landfills; discharge of waste chemicals
<a href="#">Pentachlorophenol</a>	zero	0.001	Liver or kidney problems; increased cancer risk	Discharge from wood preserving factories
<a href="#">Picloram</a>	0.5	0.5	Liver problems	Herbicide runoff
<a href="#">Simazine</a>	0.004	0.004	Problems with blood	Herbicide runoff
<a href="#">Styrene</a>	0.1	0.1	Liver, kidney, or circulatory system problems	Discharge from rubber and plastic factories; leaching from landfills
<a href="#">Tetrachloroethylene</a>	zero	0.005	Liver problems; increased risk of cancer	Discharge from factories and dry cleaners
<a href="#">Toluene</a>	1	1	Nervous system, kidney, or liver problems	Discharge from petroleum factories
<a href="#">Toxaphene</a>	zero	0.003	Kidney, liver, or thyroid problems; increased risk of cancer	Runoff/leaching from insecticide used on cotton and cattle
<a href="#">2,4,5-TP (Silvex)</a>	0.05	0.05	Liver problems	Residue of banned herbicide
<a href="#">1,2,4-Trichlorobenzene</a>	0.07	0.07	Changes in adrenal glands	Discharge from textile finishing factories
<a href="#">1,1,1-Trichloroethane</a>	0.20	0.2	Liver, nervous system, or circulatory problems	Discharge from metal degreasing sites and other factories
<a href="#">1,1,2-Trichloroethane</a>	0.003	0.005	Liver, kidney, or immune system problems	Discharge from industrial chemical factories
<a href="#">Trichloroethylene</a>	zero	0.005	Liver problems; increased risk of cancer	Discharge from metal degreasing sites and other factories

Contaminant	MCLG <sup>1</sup> (mg/L) <sub>2</sub>	MCL or TT <sup>1</sup> (mg/L) <sub>2</sub>	Potential Health Effects from Long-Term Exposure Above the MCL (unless specified as short-term)	Sources of Contaminant in Drinking Water
<a href="#">Vinyl chloride</a>	zero	0.002	Increased risk of cancer	Leaching from PVC pipes; discharge from plastic factories
<a href="#">Xylenes (total)</a>	10	10	Nervous system damage	Discharge from petroleum factories; discharge from chemical factories

**Radionuclides**

Contaminant	MCLG <sup>1</sup> (mg/L) <sub>2</sub>	MCL or TT <sup>1</sup> (mg/L) <sub>2</sub>	Potential Health Effects from Long-Term Exposure Above the MCL (unless specified as short-term)	Sources of Contaminant in Drinking Water
<a href="#">Alpha particles</a>	none ----- zero	15 picocuries per Liter (pCi/L)	Increased risk of cancer	Erosion of natural deposits of certain minerals that are radioactive and may emit a form of radiation known as alpha radiation
<a href="#">Beta particles and photon emitters</a>	none ----- zero	4 millirems per year	Increased risk of cancer	Decay of natural and man-made deposits of certain minerals that are radioactive and may emit forms of radiation known as photons and beta radiation
<a href="#">Radium 226 and Radium 228 (combined)</a>	none ----- zero	5 pCi/L	Increased risk of cancer	Erosion of natural deposits
<a href="#">Uranium</a>	zero	30 ug/L as of 12/08/03	Increased risk of cancer, kidney toxicity	Erosion of natural deposits

**Notes**

<sup>1</sup> Definitions: Maximum Contaminant Level Goal (MCLG) - The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety and are non-enforceable public health goals. Maximum Contaminant Level (MCL) - The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to MCLGs as feasible using the best available treatment technology and taking cost into consideration. MCLs are enforceable standards. Maximum Residual Disinfectant Level Goal (MRDLG) - The level of a drinking water disinfectant below which there is no known or expected risk to health. MRDLGs do not reflect the benefits of the use of disinfectants to control microbial contaminants. (TT) Treatment Technique - A required process intended to reduce the level of a contaminant in drinking water. Maximum Residual Disinfectant Level (MRDL) - The highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.

<sup>2</sup> Units are in milligrams per liter (mg/L) unless otherwise noted. Milligrams per liter are equivalent to parts per million.

<sup>3</sup> EPA's surface water treatment rules require systems using surface water or ground water under the direct influence of surface water to (1) disinfect their water, and (2) filter their water or meet criteria for avoiding filtration so that the following contaminants are controlled at the following levels:

- *Cryptosporidium*: Unfiltered systems are required to include *Cryptosporidium* in their existing watershed control provisions.
- *Giardia lamblia*: 99.9% removal/inactivation
- Viruses: 99.99% removal/inactivation
- *Legionella*: No limit, but EPA believes that if *Giardia* and viruses are removed/inactivated, according to the treatment techniques in the Surface Water Treatment Rule, *Legionella* will also be controlled.
- Turbidity: For systems that use conventional or direct filtration, at no time can turbidity (cloudiness of water) go higher than 1 nephelometric turbidity unit (NTU), and samples for turbidity must be less than or equal to 0.3 NTU in at least 95 percent of the samples in any month. Systems that use filtration other than the conventional or direct filtration must follow state limits, which must include turbidity at no time exceeding 5 NTU.
- HPC: No more than 500 bacterial colonies per milliliter.
- Long Term 1 Enhanced Surface Water Treatment: Surface water systems or (GWUDI) systems serving fewer than 10,000 people must comply with the applicable Long Term 1 Enhanced Surface Water Treatment Rule provisions (e.g. turbidity standards, individual filter monitoring, *Cryptosporidium* removal requirements, updated watershed control requirements for unfiltered systems).
- Long Term 2 Enhanced Surface Water Treatment Rule This rule applies to all surface water systems or ground water systems under the direct influence of surface water. The rule targets additional *Cryptosporidium* treatment requirements for higher risk systems and includes provisions to reduce risks from uncovered finished water storage facilities and to ensure that the systems maintain microbial protection as they take steps to reduce the formation of disinfection byproducts.
- Filter Backwash Recycling; The Filter Backwash Recycling Rule requires systems that recycle to return specific recycle flows through all processes of the system's existing conventional or direct filtration system or at an alternate location approved by the state.

<sup>4</sup> No more than 5.0% samples total coliform-positive in a month. (For water systems that collect fewer than 40 routine samples per month, no more than one sample can be total coliform-positive per month.) Every sample that has total coliform must be analyzed for either fecal coliforms or *E. coli* if two consecutive TC-positive samples, and one is also positive for *E. coli* fecal coliforms, system has an acute MCL violation.

<sup>5</sup> Fecal coliform and *E. coli* are bacteria whose presence indicates that the water may be contaminated with human or animal wastes. Disease-causing microbes (pathogens) in these wastes can cause diarrhea, cramps, nausea, headaches, or other symptoms. These pathogens may pose a special health risk for infants, young children, and people with severely compromised immune systems.

<sup>6</sup> Although there is no collective MCLG for this contaminant group, there are individual MCLGs for some of the individual contaminants:

- Trihalomethanes: bromodichloromethane (zero); bromoform (zero); dibromochloromethane (0.06 mg/L); chloroform (0.07mg/L).
- Haloacetic acids: dichloroacetic acid (zero); trichloroacetic acid (0.02 mg/L); monochloroacetic acid (0.07 mg/L). Bromoacetic acid and dibromoacetic acid are regulated with this group but have no MCLGs.

<sup>7</sup> Lead and copper are regulated by a Treatment Technique that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps. For copper, the action level is 1.3 mg/L, and for lead is 0.015 mg/L.

<sup>8</sup> Each water system must certify, in writing, to the state (using third-party or manufacturer's certification) that when acrylamide and epichlorohydrin are used to treat water, the combination (or product) of dose and monomer level does not exceed the levels specified, as follows:

- Acrylamide = 0.05% dosed at 1 mg/L (or equivalent)
- Epichlorohydrin = 0.01% dosed at 20 mg/L (or equivalent)

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## National Secondary Drinking Water Regulations

National Secondary Drinking Water Regulations (NSDWRs or secondary standards) are non-enforceable guidelines regulating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water. EPA recommends secondary standards to water systems but does not require systems to comply. However, states may choose to adopt them as enforceable standards.

- [National Secondary Drinking Water Regulations](#) - The complete regulations regarding these contaminants available from the Code of Federal Regulations Web Site.
- For more information, read [Secondary Drinking Water Regulations: Guidance for Nuisance Chemicals](#).

### List of National Secondary Drinking Water Regulations

Contaminant	Secondary Standard
Aluminum	0.05 to 0.2 mg/L
Chloride	250 mg/L
Color	15 (color units)
Copper	1.0 mg/L
Corrosivity	noncorrosive
Fluoride	2.0 mg/L
Foaming Agents	0.5 mg/L
Iron	0.3 mg/L
Manganese	0.05 mg/L
Odor	3 threshold odor number
pH	6.5-8.5
Silver	0.10 mg/L
Sulfate	250 mg/L
Total Dissolved Solids	500 mg/L
Zinc	5 mg/L

### Unregulated Contaminants

This list of contaminants which, at the time of publication, are not subject to any proposed or promulgated national primary drinking water regulation (NPDWR), are known or anticipated to occur in public water systems, and may require regulations under SDWA. For more information check out the list, or visit the Drinking Water Contaminant Candidate List (CCL) web site.

- [Drinking Water Contaminant Candidate List 2](#)
- [Drinking Water Contaminant Candidate List \(CCL\) Web Site](#)
- [Unregulated Contaminant Monitoring Program \(UCM\)](#)
- **Information on specific unregulated contaminants**
  - [MTBE \(methyl-t-butyl ether\) in drinking water](#)

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